Indian Meteorological Memoirs:

BEING

OCCASIONAL DISCUSSIONS AND COMPILATIONS OF METEOROLOGICAL DATA

RELATING TO

INDIA AND THE NEIGHBOURING COUNTRIES.

Published by order of His Excellency the Viceroy and Governor General of India in Council.

UNDER THE DIRECTION OF

HENRY F. BLANFORD, F.R.S.,

METEOROLOGICAL REPORTER TO THE GOVERNMENT OF INDIA.

VOL. IV, PART V.

VIII.—THE CYCLONE OF THE 25TH MAY TO THE 2ND JUNE 1881 IN THE ARABIAN SEA.

CALCUTTA:

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

1888.

Price Three Rupees.

VIII.—The Cyclone of the 25th May to the 2nd June 1881 in the Arabian Sea, by FREDERICK CHAMBERS, *Meteorological Reporter for Western India.*

RECEIVED ON THE 29TH DECEMBER 1887.

INTRODUCTION.

This paper gives an account of the violent cyclone which occurred in the Arabian Sea between the 25th of May and the 2nd of June 1881. The history of the storm is preceded, in the first chapter, by a brief general description of the meteorology of the Arabian Sea, and that part of the Indian Ocean which lies to the north of the Tropic of Capricorn. In this chapter it is shown that almost all the tropical cyclones of these seas originate in the equatorial belt of low atmospheric pressure. The general distribution of cyclones in these seas in different seasons of the year is worked out, but little is said on the theory of cyclone formation—a subject which has been very satisfactorily elucidated by Ferrel in his Meteorological Researches. The meteorology of the shores of the Arabian Sea in May 1881 is very briefly described and compared with the normal meteorological conditions of the month; but, unfortunately, it has not been possible to work out satisfactorily the special meteorological conditions which prevailed over the Arabian Sea before the commencement of the cyclone, the necessary information not having been obtainable.

In the second chapter the daily history of the storm is related. Before drawing the charts which illustrate this chapter, the barometric and thermometric observations were carefully corrected for index errors, which were in almost all cases determined by comparing the instruments used on board the ships indirectly with the standard instruments of the Colaba Observatory, Bombay. How very necessary this precaution to secure accuracy is, will be seen when it is pointed out that the errors of the barometers varied from about six-tenths of an inch below the truth to about two-tenths above it, and that in half the cases the errors exceeded one-tenth of an inch. The barometric observations were not only corrected for index errors, but also reduced to 32° Fahr. and to sea-level. They were next curved under each other for verification by intercomparison, and all erroneous observations thus brought to light were eliminated. They were then laid down on charts, and all glaringly inconsistent readings were rejected. In many cases the isobars are to a great extent conjectural, but they have always some evidence to rest upon, at least in some part of their course, and the rest has been filled in, where necessary, by assuming that their general form would approximate to that of a circle. The systematic and unexpected departures from symmetry which appear in the final results must therefore be inherent in the observations, and cannot be attributed

in any measure to bias of the mind while constructing the isobars, such bias, where existing, having been exerted rather on behalf of symmetry than against it. Before entering the barometric observations recorded at land stations on the charts, a correction for diurnal variation, to reduce them from 10 A.M. to noon, was applied to make them comparable with the noon observations recorded on the ships out at sea. The changes of pressure from day to day, on land, were so small that the proportionate change in two hours was negligible in all cases. The positions of the ships involved in the storm are frequently doubtful to a considerable extent, but in order to reduce the uncertainty as far as possible, the positions have in many cases been twice determined by dead reckoning, first, from the position last found by observation before entering the storm field, and secondly, by reckoning backwards from that first found by observation after leaving the storm field; and the mean of these two determinations has generally been adopted. In some cases, however, where the discrepancy between the two determinations by dead reckoning was great, and the intervals of time on which the two determinations depended differed much from each other, that determination which depended on the shortest interval of time was adopted. No attempt has been made to correct the wind observations for errors caused by motion of the ship. Such errors will tend to balance each other in the process of calculating average results.

In the third and last chapter the results are summarised and discussed, bringing to light the important fact that, at a constant distance from the centre of the cyclone, the incurvature of the winds on different sides varied in a systematic way from nothing to four points of the compass. This result proves that the usual rule for finding the bearing of the centre of a cyclone, *viz.*, six points to the left, when standing with the back to the wind, may be as much as two points in error one way or the other, and that consequently the rule requires very considerable modification. The systematic deviations from symmetry in the different octants of the cyclone have been traced to the influence which the south-westerly monsoon wind exerts upon the cyclone wind; and suitable modifications have been made in the rule for finding the bearing of the centre, so as to eliminate the error arising from this influence. The discovery of this relation between the south-westerly monsoon wind and the form of the cyclone appears to throw considerable light on the difficult subject of the bodily motion of cyclones, and from the conclusions arrived at in this chapter, the following inference has been drawn for use provisionally:—The direction of motion of cyclones in the Arabian Sea in May and June is about six points to the left of the direction towards which the normal monsoon wind blows.

CHAPTER I.

THE METEOROLOGY OF THE ARABIAN SEA AND THE ADJACENT PARTS OF THE INDIAN OCEAN.

The charts of meteorological information, published by the Hydrographic Department of the Admiralty in 1872, afford the best general view of the meteorological conditions of the Arabian Sea and Indian Ocean that is yet obtainable. These charts show the prevailing winds, the tracks of many well-authenticated storms, and the distribution of

barometric pressure and temperature in each quarter of the year. Recently, more detailed wind, pressure and current charts of the Bay of Bengal and adjacent parts of the Indian Ocean north of the equator, compiled by Mr. W. L. Dallas, have been published by the Meteorological Department of the Government of India, and similar charts of the Arabian Sea will shortly be issued. These charts show the prevailing winds and the pressure distribution in each month of the year. The Admiralty chart for the first quarter of the year shows that the north-east monsoon, or trade wind, extends over nearly the whole of the Arabian Sea, and as far south as the equator. Only along a narrow strip of sea near the west coast of India is the steady trade wind drawn out of its course, and converted into a north-west wind by the influence of the heated land. On nearing the equator the wind gradually changes into a north wind, and passing onward into the Southern Indian Ocean becomes at last a north-west wind, which prevails as far as 10° south latitude. Near the coast of Africa, the charts show an extension of north-easterly winds as far south as the middle of the Mozambique Channel; but far out in the sea, away from the coast, the winds to the south of the equator lose their tendency to blow from eastward, and, like those in the middle of the Indian Ocean, become first northerly, and afterwards north-westerly, and terminate about 10° S. The easterly direction near the African coast is therefore, in all probability, a deflection of the north-west trade wind caused by the heated land, just as in the case of the deflection from north-eastward to north-westward along the west coast of India. Over the greater part of the South Indian Ocean, from latitude 13° S to 27° S, and from Madagascar eastward, the south-east trade wind prevails, while the intermediate zone, between latitude 10° S and 13° S is a region of calms and conflicting north-west and south-east winds. It is, in fact, the meeting place of the north-westerly and south-easterly trades. A line drawn along the middle of this zone coincides with the position of the thermal equator, and with the middle of a belt of relatively low atmospheric pressure. On the chart for the first quarter, eight storm tracks are marked, all traversing the South Indian Ocean. All these storms appear to have originated in or near the belt of calms, and to have travelled at first in a south-westerly direction.

In the chart for the second quarter of the year (April, May and June) the south-east trade wind of the South Indian Ocean extends much farther northward than in the previous quarter, *viz.*, to about 4° S instead of to 13° S, the calm belt has moved northward to near the equator, and the north-east monsoon has given place to south-westerly winds in the western half of the Arabian Sea, and to variable north-westerly to south-westerly winds in the eastern half; the thermal equator has moved northward to the neighbourhood of the equator, and the high barometric pressure which characterised the Arabian Sea in the previous quarter has disappeared, and given place to relatively low pressure in the north. At the same time, the pressure has increased considerably over the area of the south-east trade winds to the south of the equator. The number of storm tracks in the South Indian Ocean has fallen from eight in the previous quarter to three in the second quarter of the year, while the number marked in the Bay of Bengal and the Arabian Sea has risen from none to seven, four in the former region, and three in the latter. The storms of the South Indian Ocean all travelled in a south-westerly direction, while six of those in the Bay of Bengal and Arabian Sea moved in a north-westerly direction, and one took a westerly course. The information contained in this chart is largely supplemented by that given in Mr. Dallas's Meteorological charts of the

Arabian Sea for the months of May and June, proof copies of which have been kindly placed at my disposal. The chart for May shows that near the equator, and along the western and northern shores of the Arabian Sea, the prevailing winds are south-westerly, while on the eastern shore they are westerly or north-westerly. In the middle of the sea, however, they are still northerly. Hence it may be inferred that there is an area of relatively low barometric pressure between the middle of the sea and the equator. The disposition of the isobaric lines supports this view, for although they show that the pressure is lowest in the extreme north and highest in the south-west near the equator, yet the relatively great distance between the isobars of 29·90 and 29·85 clearly indicates the existence of an area of relatively low pressure across the middle of the sea. The former line runs across the south-east corner of the chart, and the latter runs almost parallel to the Arabian and Indian coasts at an average distance from the coast of about 300 miles, leaving a space about 900 miles wide between the two lines, except near the African coast, where they approach much nearer. In the northern part of the Arabian Sea the isobaric lines for each five hundredth of an inch of mercury are, on the average, only 200 miles apart. The Meteorological chart of the Arabian Sea for the month of June shows a further fall of pressure in the north and north-east, and a further rise in the south-west, causing the broad band of nearly uniform pressure in the middle of the sea to disappear. It also shows that the south-west monsoon current is well established over the whole of the Arabian Sea, and southward to the equator.

The Admiralty chart for the third quarter of the year (July, August and September) shows that the south-east trade wind blows steadily over the whole of the South Indian Ocean from 25° S to the equator; that it there veers to south, and on passing the equator veers still further, until it becomes the steady south-west monsoon current of the Arabian Sea. Near the west coast of India, to the southward of Bombay, it veers even to west and west-north-west. In the neighbourhood of the equator to the southward of the eastern half of the Arabian Sea, calms are of frequent occurrence. Indeed in the five degree square lying between latitudes 0° and 5° S, and longitudes 70° and 75° E, about one-third of the total number of observations of winds and calms are recorded as calms. It is difficult to understand the occurrence of these calms during the third quarter of the year, for, at this time, the thermal equator has moved far to the northward, where it stretches across Arabia, Beluchistan and Northern India; and the region of lowest pressure, towards which the winds must necessarily tend, is also far away in the north over the heated land. The equatorial tract is therefore no longer the meeting place of oppositely directed currents of air, which by neutralising each other might account for calms. The only apparent explanation is, that the prevailing winds show a tendency to rotate in a right-handed direction round this region, and if this tendency should at times be decidedly developed, it would create a very feeble cyclonic depression of the barometer with a calm centre, purely as an effect of the centrifugal force arising from the circulating winds. The isobaric chart shows no centre of low pressure in this region, but the lines are here wider apart than to the eastward or westward, thus suggesting the probability of the occasional, if not frequent, creation of a very slight depression. The isothermal chart for July shows that the thermal equator has been transferred from near the geographical equator to the northward of the Arabian Sea, and the isobaric chart for the quarter shows that the pressure has fallen in the north and risen in the neighbourhood of the equator.

No storm tracks are marked on the chart for the third quarter, but it is now known, chiefly from the reports of Mr. Eliot, that feeble cyclonic storms are of frequent occurrence in the north of the Bay of Bengal during the months of July, August and September, and that they usually travel across the Indian Peninsula in a west-north-west direction, and sometimes pass out into the Arabian Sea to the southward of Karachi.

The chart for the last quarter of the year (October, November and December) shows a very complete change in all the meteorological conditions of the Arabian Sea and the Indian Ocean. The change is so great that it has been necessary to mark the limits of the different winds for each month separately. In October the south-westerly winds have ceased to blow, and calms and variable light winds prevail over the whole of the Arabian Sea, and as far south as 5° N latitude. Between this latitude and the equator, however, south-westerly winds are still blowing, and over the whole of the area to the south of the equator, as far as about 27° S, the south-east trade prevails. In November, the north-east monsoon, or trade wind, has made its appearance over the northern part of the Arabian Sea as far south as 10° N latitude, and the northern limit of the south-east trade of the South Indian Ocean is marked on the chart as having retreated to about 7° S. In the intermediate area, *viz.*, that lying between 10° N, and 7° S, the winds appear to vary much, chiefly between north-west and south-west, with frequent calms. The wind chart of the Bay of Bengal for November shows that between the equator and 4° N latitude, the winds are usually from some westerly point; but a little farther northward, between 4° and 8° N latitude, they are very variable, coming from nearly all points of the compass, except from south. The most important point to be noticed is that a belt of variable winds and calms stretches across the south of the Bay along the parallel of 6° N latitude. In December the Admiralty chart shows that the south-east trade has retreated to about 12° S. latitude, that the north-east monsoon or trade has advanced farther southward to about 4° N latitude on the eastern side of the Arabian Sea, and across the equator on the western side, extending farthest south along the coast of Africa, where it is traceable to about 10° S latitude. Between the equator and latitude 7° S, north-west winds prevail, leaving between them and the south-east trades a belt about 5° wide, where calms are of frequent occurrence. In October the thermal equator passes across the extreme north of the Arabian Sea, but in December it has retreated to about 10° S of the equator. It must, therefore, have travelled rapidly southward in the two intermediate months. Judging from observations made at Zanzibar during several recent years, and from the isobaric chart for the last quarter of the year, it appears that in the middle of the period, that is, in November, a band of relatively low atmospheric pressure stretches across the Indian Ocean in the neighbourhood of the equator. On the wind chart for the last quarter, eleven storm tracks are marked in the Indian Ocean and its arms, the Bay of Bengal and the Arabian Sea. Four of these originated near the equatorial calm belt in the South Indian Ocean and moved at first in the south-westerly direction, while six originated in the Bay of Bengal and moved in a north-westerly direction, and two passed across the Arabian Sea in the same direction.

The facts here very briefly described indicate, in a general way, the larger meteorological features of the Arabian Sea, and of the western half of that portion of the Indian Ocean which lies between the tropics, and they show the character of the atmospheric changes that take place over this area in the course of the year. Most of them are very

satisfactorily explained by the theory of the trade winds. This theory is useful, not only because it affords a rational account of the observed phenomena, but because it enables the mind to grasp the otherwise disconnected facts, and form them into a connected and an easily remembered whole. Briefly, the wind system of the Indian Ocean, like the wind system of the Atlantic and the Pacific Oceans, consists essentially of a north-easterly current to the north of the equator, and of a south-easterly current to the south of it, both flowing towards a relatively calm belt of maximum temperature and of minimum barometric pressure in the neighbourhood of the equator, where they rise and flow over in the upper regions of the atmosphere. The cause of the high temperature and low pressure in the equatorial regions is of course the heat of the sun, and if the sun were always to remain vertically over the equator, this wind system would remain throughout the year of the same character, but the annual motion of the sun, to and fro, through 47° of declination, gives rise to a corresponding bodily transfer of the calm belt from one hemisphere to the other, and this leads to corresponding modifications of the wind system. The bearing of the to-and-fro motion of this belt on the subject of cyclone formation is of very great importance, because there is reason to believe that nearly all the cyclones which occur within the tropics originate in the equatorial belt of calms, and, consequently, a knowledge of where this belt is situated at different times of the year carries with it a knowledge of the times when cyclones are most likely to be met with in different parts of the sea.

The reason why the currents of air on both sides of the thermal equator do not blow in a direct line towards it is that, in consequence of the rotation of the earth, bodies in motion on the earth's surface have a tendency to turn to the right in the northern hemisphere, and to the left in the southern hemisphere; and thus the current on the northern side of the equatorial calm belt, instead of blowing from north, turns to the right and becomes a north-east wind, while the current on the south side, instead of blowing from south, turns to the left and becomes a south-east wind. Hadley first pointed out the effect of the earth's rotation in deflecting north and south winds respectively into north-east and south-west winds in the northern hemisphere, and into north-west and south-east winds in the southern hemisphere; and for a long time it was supposed that the earth's rotation had no turning effect on east and west winds; but the comparatively recent mathematical investigations of Ferrel have shown that the deflecting force, due to the earth's rotation, affects winds from all directions in an equal degree, and that this force is twice as great as the earlier investigators had supposed. Its intensity varies as the sine of the latitude. It therefore vanishes at the equator, and is greatest at the poles. It turns the wind towards the right in the northern hemisphere, and towards the left in the southern, but it cannot of itself originate motion, and it is only called into action when motion has already been created by some other force. It acts always at right angles to the direction in which the wind is moving, but it does not, in any practical case, deflect it more than a right angle from the direction towards which the originating force impels it. This principle explains many peculiarities in the behaviour of the winds which were formerly supposed to militate against the truth of the theory of the trade winds; for instance, it explains why the winds of the western coast of India, in the hot weather months, March, April and May, blow from north-west instead of in a direct line from west towards the heated land, the westerly wind having been deflected to the right by the deviating force arising from the earth's

rotation. It also explains the well-ascertained fact that, in cyclones, the wind blows, not in a direct line towards the centre, in simple obedience to the originating force of the cyclone, but in some direction between the radius and the tangent to the circle drawn round the centre, on the right side of the radius, looking towards the centre, in the northern hemisphere, and on the left side in the southern, thus giving rise to the left-handed rotation of the wind (against the hands of a watch) round the centre of the cyclone in the northern hemisphere, and the right-handed rotation (with the watch hands) in the southern hemisphere. Like all true principles, it explains a multitude of other facts regarding the movements of the atmosphere, the sea, and solid bodies which would be inexplicable without it. It accounts for the fact that when in the Indian Ocean the thermal equator is to the south of the geographical equator, as it is in February, the trade wind on the north side of the thermal equator gradually changes its direction from north-east through north to north-west, the direction being north-east in the northern hemisphere, where the deflecting force is towards the right, north at the equator, where the deflecting force vanishes leaving the wind to go straight to the thermal equator, and north-west in the southern hemisphere, where the deflecting force acts towards the left. It also accounts for the similar change of direction of the trade wind on the south side of the thermal equator when the latter follows the sun into northern latitudes, as it does in the northern summer, for then the trade wind blows from south-east as far as the equator, veers to south on the equator, and to south-west to the north of the equator, in perfect accordance with the above-mentioned principle.

The mean position of the equatorial belt of high temperature and low atmospheric pressure in each month of the year is not yet known with very great accuracy. Some further light will doubtless be thrown on this important subject by the Meteorological charts of the Arabian sea, now passing through the press, but until similar charts of the south Indian Ocean are also prepared and published, our knowledge of this matter will necessarily be imperfect.

Meanwhile, much valuable information on this point may be gleaned from observations recorded at land stations on or near the shores of the Arabian Sea and Indian Ocean. With this object in view, the following table of average sea-level pressures for each month of the year has been compiled from the annual report on the Meteorology of India for the year 1885.

TABLE I.

STATION.	Latitude.	Longitude.	Number of years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
Aden . . .	12° 45′N	45° 3′E	4—6	30·053	29·998	29·956	29·878	29·810	29·709	29·660	29·678	29·765	29·917	29·998	30·044	29·872
Bushire . . .	28° 59′	50° 49′	7—8	·126	30·062	·980	·862	·745	·563	·469	·522	·696	·916	30·045	·102	·841
Kurrachee . .	24° 47′	67° 4′	11	·061	·018	·923	·825	·697	·562	·528	·613	·734	·900	·004	·069	·827
Bhuj . . .	23° 15′	69° 42′	11	·058	·006	·926	·816	·710	·586	·556	·636	·740	·890	29·993	·052	·831
Rajkot . . .	22° 17′	70° 52′	11	·041	29·991	·916	·820	·723	·605	·596	·667	·764	·895	·977	·028	·835
Surat . . .	21° 13′	72° 46′	11	·008	·972	·912	·826	·761	·658	·635	·697	·772	·877	·950	29·996	·839
Bombay . . .	18° 54′	72° 49′	39	29·979	·948	·901	·836	·792	·695	·693	·751	·808	·868	·936	·973	·848

Station.	Latitude.	Longitude.	Number of years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
Ratnagiri . .	17° 0′N	73° 23′E	11	29·976	29·945	29·904	29·832	29·793	29·741	29·749	29·785	29·832	29·867	29·905	29·949	29·85[illegible]
Karwar . . .	14° 50′	74° 15′	8	·968	·945	·912	·848	·806	·785	·799	·814	·856	·869	·891	·938	·86[illegible]
Mangalore . .	12° 52′	74° 54′	8	·951	·937	·911	·865	·818	·819	·831	·845	·880	·878	·886	·927	·87[illegible]
Cochin . . .	9° 58′	76° 17′	14–15	·929	·921	·904	·854	·837	·857	·873	·877	·898	·892	·901	·920	·88[illegible]
Colombo. . .	6° 56′	79° 52′	16–17	·927	·925	·912	·865	·850	·864	·878	·880	·904	·902	·901	·915	·894
Galle . . .	6° 1′	80° 14′	15–17	·930	·924	·914	·867	·847	·867	·881	·882	·907	·905	·903	·914	·895
Zanzibar. . .	6° 10′S	39° 11′	7–9	·888	·889	·887	·915	·991	30·071	30·089	30·074	30·051	·998	·933	·908	·974
Mauritius . .	20° 10′S	57° 29′	24–25	·946	935	·980	30·013	30·084	·175	·212	·207	·195	30·136	30·064	30·002	30·078

From this table an estimate of the normal pressure at any time of the year, and in any part of the Arabian Sea, may readily be made by interpolation, and if the estimate is made with care, the result will seldom deviate more than two or three hundredths of an inch from the truth. The importance of being able to make such an estimate will be seen hereafter.

In compiling Table I, the following corrections have been applied—for Galle +·027, for Colombo +·014, for Ratnagiri +·009, for Surat +·003, for Rajkot +·009, and for Bhuj +·015. These corrections have been determined by plotting out the annual means on a form ruled to scale, the vertical scale being taken to represent the height of the barometer, and the horizontal scale the latitude. A smooth free-hand curve was then drawn through the points given by the observations of Cochin, Mangalore, Karwar, Bombay and Kurrachee, all of which showed a regular progressive decrease of pressure from south to north, and the deviations of the points given by the observations of the remaining stations from this curve were regarded as constant errors of observation or of instrument. All the observations were first reduced to the Bombay standard barometer, which agrees with the Kew standard. The observations have also been reduced to what they would be if the force of gravity were constant in all latitudes, and had the value which it has in latitude 45°. The resulting values are given in Table II.

Table II.

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
Aden . . .	29·977	29·922	29·880	29·802	29·734	29·633	29·584	29·602	29·689	29·841	29·922	29·968	29·796
Bushire . .	30·081	30·017	·935	·817	·700	·518	·424	·477	·651	·871	30·000	30·057	·796
Kurrachee . .	·006	29·963	·868	·770	·637	·507	·473	·558	·679	·845	29·949	·014	·772
Bhuj . . .	29·999	·947	·867	·757	·651	·527	·497	·577	·681	·831	·934	29·993	·772
Rajkot . .	·980	·930	·855	·768	·662	·544	·535	·606	·703	·834	·916	·967	·774
Surat . . .	·945	·909	·849	·763	·698	·595	·572	·634	·709	·814	·887	·933	·776
Bombay . .	·912	·881	·834	·769	·725	·628	·626	·684	·741	·801	·869	·906	·781

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
Ratnagiri . .	29·906	29·875	29·834	29·762	29·723	29·671	29·679	29·715	29·762	29·797	29·835	29·879	29·786
Karwar . .	·894	·871	·838	·774	·732	·711	·725	·740	·782	·795	·817	·864	·795
Mangalore . .	·875	·861	·835	·789	·742	·743	·755	·769	·804	·802	·810	·851	·803
Cochin . .	·849	·841	·824	·774	·757	·777	·793	·797	·818	·812	·821	·840	·809
Colombo . .	·845	·843	·830	·783	·768	·782	·796	·798	·822	·820	·819	·833	·812
Galle . . .	·848	·842	·832	·785	·765	·785	·799	·800	·825	·823	·821	·832	·813
Zanzibar . .	·806	·807	·805	·833	·909	·989	30·007	·992	·969	·916	·851	·826	·892
Mauritius . . .	·878	·858	·904	·942	30·015	30·102	·136	30·144	30·130	30·069	30·004	·933	30·010

The full significance of the pressures of Table II is best seen by plotting the values of each month on a form ruled to scale, taking the vertical scale to represent the barometic pressure, and the horizontal scale the latitude, and joining up corresponding points in the manner shown in Plate XXV. Each line of this diagram represents, for the month marked upon it, a barometric section of the atmosphere along a line passing through the respective stations[1]. Each of the lines for the months October to March shows a well-marked trough-like depression with sloping sides. In October the bottom of the trough, or, in other words, the lowest pressure, is in Lat. 16° N; in November it is in Lat. 8° N; in December it is near the equator; in January it is in Lat. 6° S; and in February it has reached its farthest southerly limit, probably in Lat. 10° to 12° S. This gradual southerly transfer of the lowest pressure from Lat. 16° N in October, to about 10° S in February, is brought about by the gradual rising of the northern slope of the trough and the simultaneous gradual falling of the southern slope, the two changes producing what may be described as a bodily movement of the trough from north to south. In March the direction of motion is reversed and the trough begins to move northward, the southern slope beginning to rise and the northern slope to fall, bringing the lowest pressure again to about 6° S Lat. In April the bottom of the trough appears to be suddenly transferred to about Lat. 22° N, but there is reason to believe that this is due to the formation of an independent area of low pressure over the land as the summer advances, and that the equatorial trough of low pressure still exists in this month not far from the equator, although it is not clearly shown by the land observations. The Annual Reports on the Meteorology of India by Mr. H. F. Blanford clearly show that an independent area of low pressure forms over the land as early as February, and gradually deepens and moves northward as the season advances. The gradual deepening of this barometric depression over the land, and its northward movement, are clearly indicated by the barometric sections for May, June and July, and these show that at the same time the pressure gradually increases in the regions between the equator and 20° S Lat., thus causing the bottom of the southern barometric slope to move farther and farther northward. The effect on the equatorial trough of low pressure of the formation of the barometric depression over the land is gradually to bend down the upper part of the northern slope of the trough, until eventually, by the depression of the

[1] To avoid overcrowding, the pressure values of only nine stations out of the fifteen have been plotted on the diagram.

northern slope and the simultaneous elevation of the southern slope, the ridge of relatively high pressure which separates the land minimum from the equatorial depression entirely disappears, and then a single continuous barometric slope from south to north is established. The disappearance of this ridge probably takes place early in June, simultaneously with what is known in Western India as the "bursting of the monsoon." Its existence in May is clearly indicated on Mr. Dallas's Meteorological chart of the Arabian Sea for that month, and its complete disappearance in the following month is clearly proved by the chart for June. Barometric sections of these two charts taken along the meridian of 64° E are shown on Plate XXV. The corresponding barometric readings taken from the charts, and the corrections applied to them, are given in the following table :—

TABLE III.

	Latitude.	Normal pressure.	Gravity correction.	Pressure corrected to Lat. 45°.
		Inches.	Inch.	Inches.
May	2° 0′ N	29·900	—·084	29·816
„	11° 0′ N	29·850	—·079	29·771
„	18° 3′ N	29·850	—·068	29·782
„	20° 9′ N	29·800	—·063	29·737
„	23° 0′ N	29·750	—·059	29·691
June	0° 4′ N	29·900	—·085	29·815
„	5° 6′ N	29·900	—·082	29·818
„	15° 7′ N	29·850	—·073	29·777
„	18° 0′ N	29·800	—·069	29·731
„	24° 8′ N	29·562	—·055	29·507

The last reading is the pressure at Karachi, the chart for June being blank in the extreme north of the Arabian Sea.

From this table, and from Plate XXV, it appears that in May the equatorial minimum is in about Lat. 8° N, while the land minimum is far away in the north, the two being separated by a ridge of relatively high pressure in Lat. 15° N. In accordance with this distribution of pressure the chart for May shows that the prevailing winds are southerly near the equator, northerly in the middle of the Arabian Sea, and southerly in the north of the sea, while calms are frequent about Lat. 8° N, where the equatorial belt of low pressure is situated. In June the existence of the equatorial zone of low pressure, as an outstanding feature of the barometric distribution, is no longer traceable, although it is quite possible that by the adoption of a suitable method of eliminating from the observations the effects of the land depression the farther progress northward of the equatorial minimum might be traced without much difficulty. The Bombay Meteorological observations afford strong evidence that the equatorial zone of low pressure passes Bombay, going northward, about the middle of June,[1] and the barometric sections for June shew that the equatorial minimum has in this month coalesced with the land minimum;

[1] Meteorology of the Bombay Presidency by C. Chambers, F R.S., Arts. 31 and 113.

while the sections for July, August, and September show that the two minima remain combined throughout those months; but when, with the departure of summer, the land minimum fills up, as it does in October, the equatorial minimum again makes its appearance in latitude 16° N, and the same series of changes occurs year after year. It must not be supposed that these annual movements of the equatorial belt of minimum pressure take place with perfect smoothness. The small and irregular changes of pressure which are incessantly occurring would necessarily give rise to oscillatory movements of the belt about its mean position, and it is therefore far more probable that the onward movement is the result of a series of irregular advances and retirements, the southerly movements on the whole exceeding the northerly ones from October to February, and the northerly movements exceeding the southerly ones from February to May.

The barometric sections show that from October to May there is always, at the bottom of the equatorial trough of low pressure, a broad band, extending on the average over about 15° of latitude, within which the normal pressure is very nearly uniform, the extreme difference being not more than ·03 of an inch. A fall of pressure of only ·03″ on one side of the trough and a corresponding rise on the other would therefore be sufficient to throw the bottom of the trough seven or eight degrees to the north or south of its mean position, but a relatively much greater disturbance of the normal conditions than that here supposed would be required to carry the bottom of the trough much beyond these limits, because after passing them the normal pressure increases more rapidly, and a greater disturbance would be needed to counteract it.

One of the chief characteristics of the equatorial belt of low pressure is the nearly constant rainfall which takes place in it. In this respect it is very different from the region of low pressure which forms over the land in the summer, but which gives rise to little or no rain. By this characteristic it is possible to trace the continuous northerly movement of the belt beyond the place where the barometric features of the two areas coalesce. The following table of rainfall at a few selected stations exhibits this peculiarity in a striking manner. It shows not only the gradual northward progression of the band of heavy rainfall between February and July, but also its gradual return southward between July and February. Stations on the Deccan and Malwa plateaus have been selected, because there the rainfall is less likely than on the coast to be influenced by sudden change of elevation.

TABLE IV.—*Average monthly and yearly rainfall in inches.*

Station.	Latitude.	Longitude.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November	December.	Year.
Lahore . .	31° 34′N.	74° 20′E.	0·64	1·16	1·01	0·61	0·98	1·70	7·23	4·61	2·44	0 51	0·15	0·50	21·54
Neemuch .	24° 25′N.	75° 0′E.	0·10	0·16	0·12	0·09	0·54	3·69	11·54	10·29	5·76	0·86	0·03	0·25	33·43
Malegaon .	20° 34′N.	74° 22′E.	0·24	0·18	0·02	0·25	0·69	5·03	4·22	4·27	6·39	2·37	0·42	0·60	24·68
Mysore .	12° 18′N.	76° 39′E.	0·09	0·13	0·69	2·20	5·57	1·88	2·27	3·16	3·82	6·49	1·63	0·50	28·43
Galle . .	6° 1′N.	80° 14 E.	4·29	3·41	4·83	8·70	11·06	8·31	5·36	5·37	7·61	13·07	11·67	6·28	89·96
Zanzibar .	6° 10′S.	39° 11′E.	2·32	4·17	4·88	12·68	8·26	1·19	2·20	1·92	1·33	3·35	6·31	6·41	55·02
Mauritius .	20° 10′S.	57° 29′E.	·89	12·89	8·10	4·81	4·05	2·78	3·43	4·90	2·00	2·07	2·36	7·39	63·67

From this table it appears that the rainy zone passes Latitude 20° N in June, that it advances at least as far North as 24° N in July, that it is nearly in the same position in August, and that in September it again passes Lat. 20° N on its retreat southward. It is probable therefore that its extreme excursion northward is at least as far as 24° N, and as the southerly limit of its movement is at least as far as 10° S, the full range of its oscillation in the course of the year is not less than 34° of latitude. There is no doubt that this oscillatory movement of the rainy zone has an important bearing on the frequency of occurrence of cyclones in different latitudes and different months of the year. The following table shows the number of cyclones recorded in each month of the year in the Bay of Bengal, the Arabian Sea, and the South Indian Ocean.

TABLE V.

	Number of years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Bay of Bengal .	139	2	0	2	9	21	10	3	4	6	31	18	9	115
Arabian Sea . .	234	4	3	2	9	13	20	2	2	3	4	10	2	74
South Indian Ocean.	40	9	13	10	8	4	0	0	0	1	1	4	3	53

No inference as to the relative frequency of storms in the different seas can be drawn from these numbers, because it is by no means certain that all the storms that have occurred have been recorded, and more may have passed unnoticed in one sea than in another. They show, however, the relative frequency in the different months of the year, and the data for the different seas may be made more comparable by calculating, as in the following table, how many storms occur in each month out of every hundred that occur in each sea.

TABLE VI.—*Relative Frequency of Cyclones in each Month.*

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Bay of Bengal . . .	2	0	2	8	18	9	3	3	5	27	16	8
Arabian Sea	5	4	3	12	18	27	3	3	4	5	13	3
South Indian Ocean . .	17	25	19	16	8	0	0	0	2	2	8	6

Hence it appears that cyclones in the South Indian Ocean are most frequent in February, that is to say, in the month when the equatorial zone of low pressure is farthest south of the equator. From February onward the cyclone frequency in the South Indian Ocean decreases as the equatorial belt moves northward towards the equator, and when the belt passes the equator into northern latitudes the frequency of storms in the Arabian Sea and the Bay of Bengal gradually increases, the storms becoming more and more numerous as the belt moves farther and farther from the equator, and reaching a maxi-

mum of frequency in the Bay of Bengal in May and in the Arabian Sea in June, at which time storms have entirely disappeared from the South Indian Ocean. When, however, the equatorial belt of low pressure coalesces with the land depression, and passes to the extreme north of the Arabian Sea and Bay of Bengal, the cyclone frequency in these seas drops suddenly to a minimum; but when the land depression fills up, and the equatorial band of low pressure again makes its appearance in October in about Lat. 16° N, the frequency of storms suddenly increases to a maximum, and thereafter gradually declines to a second minimum in February or March, as the belt of low pressure moves southward. As the storms decrease in frequency to the north of the equator they increase in frequency to the south of it, and again reach a maximum in the South Indian Ocean in February. All these facts are in accordance with the hypothesis that tropical cyclones originate in the equatorial belt of low pressure, and are most frequent when the belt is farthest from the equator. Clearly, then, the atmospheric conditions which characterise this belt are those which favour the development of cyclones; but as the mechanical condition which determines the gyratory motion, *viz.*, the deflecting force arising from the earth's rotation, does not operate on the equator itself, and has a very small value near the equator, cyclones are not formed in the immediate neighbourhood of the equator; when, however, the belt of low pressure moves some distance north or south of the equator, where the deflecting force acquires a sensible value, cyclones begin to make their appearance, and to increase in frequency as the deflecting force increases with increase of latitude.

The chief meteorological features of the equatorial belt of low pressure are, 1st, relatively low atmospheric pressure compared with the pressure conditions on the northern and southern sides of it; 2nd, relatively high temperature; 3rd, frequency of calms and light winds of variable direction; 4th, an atmosphere saturated with moisture; and 5th, cloudy weather and frequent heavy rain.

In order to test the hypothesis that tropical cyclones originate in the equatorial belt of low pressure, the latitude of the place of origin of each of the storms of the Indian Ocean and its arms, the Arabian Sea and Bay of Bengal, whose tracks are marked on the Admiralty wind charts, has been read from the charts, and the average latitude for each month has been taken. It is assumed that the place of origin is sufficiently well indicated for this purpose by the commencement of the track. The results are shown below:—

TABLE VII.

		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
North latitude	Number of storm.	0	0	0	4	2	0	0	0	0	3	2	2
	Mean latitude	—	—	—	13° 9	11° 0	—	—	—	—	13° 7	9° 0	8° 7
South latitude	Number of storms.	3	3	2	1	1	0	0	0	0	0	0	4
	Mean latitude	14° 0	15° 7	15° 3	12° 8	11° 3	—	—	—	—	—	—	10° 4

Few as these instances are, they clearly show that there is a progressive movement of the place of origin of storms similar to that which characterises the changes of the position of the equatorial belt of low pressure at different seasons of the year. For the

South Indian Ocean, the progressive change of the mean position of the place of origin is perfect, commencing at 10°·4 S latitude in December and increasing to 15°·7 S in February, and then gradually decreasing to 11°·3 S in May. In the Arabian Sea and the Bay of Bengal the evidence afforded by the six storms of April and May is conflicting, those of April having originated farther north than those of May instead of farther south in accordance with the position of the equatorial belt of low pressure; but the storms of October to December show a regular southward movement of the mean place of origin from 13°·7 N in October to 8°·7 N in December, in accordance with the direction of movement of the belt at this time of the year. Further evidence on this point is afforded by Mr. Eliot's monthly track charts of the south-west monsoon storms generated in the Bay of Bengal during the years 1877 to 1881. The following results have been obtained by reading from these charts the latitude of the commencement of each storm track, and by taking the mean of all the readings in the same month.

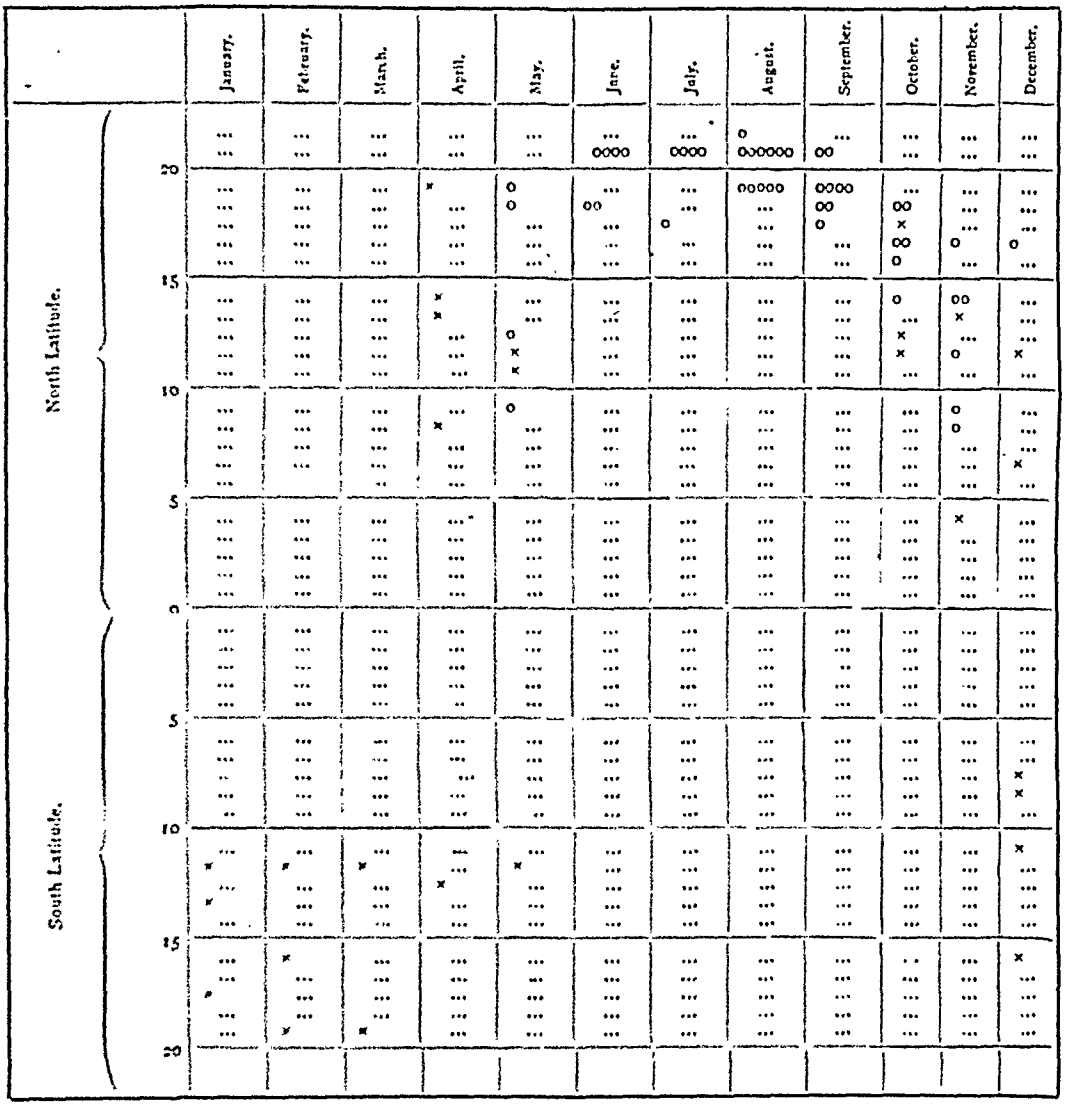
TABLE VIII.

	May.	June.	July.	August.	September.	October.	November.	December.
Number of storms	4	6	5	12	9	6	6	1
Mean north latitude of place of origin .	15° 5	19° 7	19° 8	20° 2	19° 4	16° 5	12° 7	16° 7

These show that the mean latitude of the place of origin gradually increased from 15°·5 N in May to 20°·2 N in August, and thereafter gradually decreased to 12°·7 N in November. The single storm of December appears to have been exceptional in that it originated farther north than is required by the hypothesis. It is clear, however, that the mean place of origin of these storms had a progressive movement from south to north from May to July or August, and from north to south from August to November in general agreement with the movement of the equatorial zone of low pressure. Mr. Eliot has pointed out that the position of storm tracks in the Bay of Bengal depends on the season of the year, that they are farther to the north in July than in May, and that they recede southwards from July to November.

It is a well observed fact that tropical cyclones almost invariably travel in such a direction as to increase their distance from the equator, moving usually in a north-westerly direction in the northern hemisphere, and in a south-westerly direction in the southern. If, then, these cyclones originate in the equatorial belt of low pressure, they will rarely, if ever, be met with on the equatorial side of this belt, nor on that slope of the trough of low pressure which extends into the opposite hemisphere. The distribution of cyclones in different latitudes and in different months shows that this is really the case, as will be seen from the following table in which the months are arranged horizontally and the latitudes vertically, and in which the latitude of the place of origin of each storm marked on the Admiralty Chart, and the month in which it occurred, are indicated by a cross (+) and the latitude of the beginning of each of Mr. Eliot's storm tracks and the month are indicated by a small circle.

TABLE IX.



In this table no storms are recorded as having originated in January, February, and March on the north side of the parallel of 11°S, that is, on the equatorial side of the belt of low pressure, which in these months lies to the south of the equator, nor on the northern slope of the trough of low pressure, which at this time covers the Arabian Sea and the Bay of Bengal. Conversely, no storms are recorded in this table as having originated in the months June, July, August, and September, between the equator and the parallel of 17° N, *i.e.*, on the equatorial side of the trough of low pressure, which at this time lies far to the north of the equator; nor are any recorded on the south side of the equator on the southern slope of the equatorial trough of low pressure, which in these months covers nearly the whole of the Arabian Sea, the Bay of Bengal, and the South Indian Ocean to about 25° S Lat. The absence of cyclones from these regions is therefore attributable,

1st, to the absence of the meteorological conditions which favour their development, that is, those conditions which obtain in the equatorial belt of low pressure; and 2nd, to that condition which causes cyclones, when once formed, to move away from the equator.

If the limits within which the equatorial trough of low pressure oscillates in each month could be definitely assigned, which unfortunately cannot at present be done, it would be possible to lay down with some precision the limits within which cyclones would probably be met with, and without which they would, in all probability, very rarely, if ever, occur. Meanwhile the above table furnishes some valuable information on this point, even as it stands, for it indicates the limits of latitude within which the cyclones of these seas are most likely to originate in each month of the year, and from within which they commence their north-westerly course in the northern hemisphere, and their south-westerly course in the southern.

In those months when the mean position of the equatorial belt of low pressure is very near the equator, *viz.*, in April and December, the temporary oscillations of the belt, arising from the ordinary small variations of pressure, will carry it first into one hemisphere and then into the other, and hence in these months cyclones may originate in both hemispheres, as shown by the table.

Theory of Cyclones:—In his important work on Cyclones, Waterspouts, and Tornadoes, Ferrel[1] has worked out very completely the theory of cyclones, beginning with the assumption that the atmosphere over some central area has a lower density than that over the external surrounding parts. Now the atmosphere in the equatorial zone of low pressure has a lower density than the air over the regions to the northward and southward of it. It therefore satisfies the fundamental assumption of Ferrel's theory with respect to density, but not with respect to form of the area, since the shape of the equatorial zone is not circular. What it is that occasionally converts the initial motion towards a medial line into motion towards a single centre situated on that line—the line running through the middle of the zone of low pressure—has yet to be discovered, but this appears to be the only point regarding the formation of tropical cyclones which still remains to be satisfactorily explained. Perhaps some light might be thrown on this question, if numerous accurate meteorological observations, made during the week before the commencement of a storm, could be obtained from all parts of the Arabian Sea, for such observations might possibly indicate the existence of a circular area of relatively low pressure overlying the place where the cyclone afterwards originates. Indeed it is by no means certain that the trough-like depression, which normally overlies the region where cyclones originate, does not, before the formation of a vortex, temporarily assume a circular form. Unfortunately the available meteorological information is too meagre and too uncertain to indicate clearly the actual meteorological conditions over the whole of the Arabian Sea before the formation of the cyclone of May and June 1881, and the observations recorded at land stations on the shores of the sea do not suffice for this purpose.

Meteorology of the shores of the Arabian Sea in May 1881.—The following table exhibits the mean values of the meteorological elements in May 1881 at several stations on the shores of the Arabian Sea, and compares them with the normal values of those elements:—

[1] "Meteorological Researches for the use of the Coast Pilot." Government Printing Office, Washington, 1880.

TABLE X.

Stations.	Barometric Pressure.			Wind.								Temperature.			Relative Humidity.			Cloud.			Rain.		
	Mean Pressure in May 1881.	Normal Pressure in month of May.	Abnormal Pressure in May 1881.	Mean Direction in May 1881.	Mean Percentage in May 1881.	Mean hourly Velocity in May 1881.	Normal Direction in month of May.	Normal Percentage in month of May.	Normal hourly Velocity in month of May.	Abnormal Direction in May 1881.	Abnormal Percentage in May 1881.	Abnormal hourly velocity in May 1881.	Mean Temperature in May 1881.	Normal Temperature in month of May.	Abnormal Temperature in May 1881.	Mean Relative Humidity in May 1881.	Normal Relative Humidity in month of May.	Abnormal Relative Humidity in May 1881.	Mean amount in May 1881.	Normal amount in month of May.	Abnormal amount in May 1881.	Total Rainfall in May 1881.	Normal Rainfall in month of May.	Abnormal Rainfall in May 1881.
	"	"	"			Miles.			Miles.	[1]		Miles.	°	°	°	Per cent.	Per cent.	Per cent.	Scale. 0 to 10	Scale. 0 to 10	Scale. 0 to 10	"	"	"
Zanzibar . . .	29·965	29·968	−·003	S. 15° W.	80	7·1	S. 17° W.	69	7·5	− 2°	+11	−0·4	78·3	78·4	−0·1	83	81	+ 2	6·60	6·64	−0·04	11·96	8·26	+3·73
Aden . . .	·704	·715	−·011	S. 69° E.	55	12·3	S. 79° E.	44	12·6	+10°	+11	−0·3	85·6	84·9	+0·7	67	69	− 2	...	...	...	...	0·23	−0·23
Bushire . . .	·706	·719	−·013	N. 48° W.	73	8·2	N. 56° W.	65	8·9	+ 8°	+ 8	−0·7	82·4	80·8	+1·6	60	59	+ 1	...	...	...	...	...	...
Karachi . . .	·658	·642	+·016	S. 55° W.	85	15·9	S. 86° W.	80	17·7	−31°	+ 5	−1·8	84·6	85·1	−0·5	76	74	+ 2	0·77	2·23	−1·46	...	0·05	−0·05
Bhuj	·314	·305	+·009	N. 88° W.	75	14·0	S. 88° W.	81	15·2	+ 4°	− 6	−1·2	88·7	86·6	+2·1	43	51	− 8	0·29	1·26	−0·97	...	0·17	0 17
Rajkot . . .	·292	·290	+·002	N. 74° W.	61	14·8	N. 82° W.	78	14·9	+ 8°	−17	−0·1	...	87·9	...	...	44	...	1·24	1·55	−0·31	0·10	0·33	−0·23
Surat	·716	·721	−·005	S. 54° W.	84	13·9	S. 55° W.	74	12·7	− 1°	+10	+1·2	86·9	85·5	+1·4	59	59	0	0·40	1·57	−1·17	...	0·23	−0·23
Bombay . . .	·755	·754	+·001	S. 77° W.	58	12·6	N. 85° W.	74	10·2	−18°	−16	+2·4	85·1	84·9	+0·2	75	75	0	2·91	4·05	−1·14	0·36	0·53	−0·17
Ratnagiri . . .	·673	·673	0	S. 89° W.	57	...	N. 76° W.	67	...	−15°	−10	...	84·6	83·6	+1·0	67	69	− 2	0·69	1·54	−0·85	0·53	1·36	−0·83
Karwar . . .	·772	·761	+·011	W.	76	...	N. 70° W	82	...	−20°	− 6	...	83·8	83·3	+0·5	74	74	0	4·23	3·06	+1·17	3·15	2·79	+0·36
Mangalore . . .	·766	·764	+·002	S. 88° W.	70	4·1	N. 75° W.	76	4·3	−17°	− 6	−0·2	83·4	82·9	+0·5	74	74	0	5·18	4·42	+0·76	4·50	8·03	−3·53
Calicut . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3·05	9·32	−6·27
Cochin . . .	·827	·826	+·001	N. 44° W.	55	2·1	S. 84° W.	52	2·2	+52°	+ 3	−0·1	82·2	82·0	+0·2	81	81	0	7·31	5·71	+1·60	11·66	12·58	−0·92
Colombo . . .	·786	·795	−·009	S. 42° W.	86	9·3	S. 54° W.	75	8·2	−12°	+11	+1·1	84·3	82·8	+1·5	74	79	− 5	7·00	6·75	+0·25	6·38	12·68	−6·30
Galle	·780	·779	+·001	S. 86° W.	67	7·9	S. 86° W.	61	7·5	0	+ 6	+0·4	82·9	81·8	+1·1	88	87	+ 1	6·00	6·66	−0·66	4·88	11·06	−6·18

[1] The positive sign (+) indicates that the mean direction of the wind was from the right of the normal direction; the negative sign (−) that it was from the left.

From this table it appears that on the shores of the Arabian Sea the mean barometric pressure in May 1881 differed very little from the normal pressure of the month. On the whole, there was a slight excess of pressure on the coast of India, and a slight defect on the African and Arabian coasts, and in the Persian Gulf. Along the west coast of India from Mangalore to Surat the prevailing winds were from a direction to the southward of the normal westerly directions. At other stations they differed irregularly from the normal directions. The percentages showing the prevalence or degree of steadiness of the prevailing winds indicate that along the coast from Mangalore to Bhuj the winds were not as steady as usual, but that at all other stations they were somewhat more so. At Surat and Bombay, and in Ceylon, the average velocity of the wind was greater than the normal, but at all other stations where the velocity was observed, it was less. The temperature appears to have been generally about 1° higher than the normal, and the relative humidity about normal. The actual quantity of moisture in the lower atmosphere was therefore appreciably greater than usual. But this does not appear to have been generally the case at high levels, for there was less cloud than usual at all the stations to the northward of Karwar, and at almost all, the rainfall was below the normal quantity. Only at Zanzibar was it considerably greater than usual.

CHAPTER II.

DAILY HISTORY OF THE STORM.

1881, May 25.—The following table gives the meteorological data for the 25th May 1881 at land stations round the coast of the Arabian Sea :—

TABLE XI.—*10 A. M. 25th May 1881.*

Station.	Barometer.	Change in 24 hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity mean of day.					
	"	"	"		Miles per hour.	°	Per cent.	0 to 10	"	
Zanzibar . .	30·072	+·016	+·008	WSW	4	75·9	94	10	1·92	r.
Aden . .	29·789	+·010	—·046	SSE	8	91·9	62	...	...	
Bushire . .	·695	+·023	—·021	W	4	92·7	58	...	...	
Karachi . .	·723	+·012	+·022	SW	4	89·0	69	2	...	Strong wind.
Bhuj . .	·734	+·011	+·032	WNW	13	92·4	50	0	...	b.
Rajkot . .	·755	+·012	+·024	WNW	15	94·3	43	0	...	b.
Surat . .	·794	+·016	+·013	W	21	92·5	54	0	...	
Bombay . .	·828	+·024	+·011	NW	14	89·2	67	1	0·01	
Ratnagiri . .	·818	+·046	+·009	NW	...	90·1	59	0	...	
Karwar . .	·857	+·056	+·012	NW	...	85·0	76	8	0·01	Fresh Wind.
Mangalore .	·853	+·025	0	W	5	88·4	64	7	0·02	t.
Calicut . .	·851	—·005	—·028	NNW	7	84·6	78	5	0·07	d.
Cochin . .	·861	—·045	—·026	NNE	11	86·0	81	10	1·01	o.
Colombo . .	·858	+·025	—·030	SSW	13	81·0	78	8	...	Fine.
Galle . .	·860	+·029	—·018	SW	10	83·0	94	8	0·07	

The next tabular statement contains the meteorological information for the same date, collected from the ships which were at that time on the Arabian Sea, or on the North Indian Ocean between the coast of Africa and Long. 80° E.

TABLE XII.—*25th May 1881.*

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
S. British Crown .	Noon	4° 5′ N	58° 18′ E	"	°			
	2 P.M.	...	...	...	...	SW	...	Moderate breeze and cloudy weather.
S.S. Clan Alpine .	1 A.M.	...	...	29·792	86·2	Variable	...	Light winds and cloudy weather.
	8 A.M.	...	...	...	...	NE	...	Light breeze and cloudy weather.
	Noon	15° 0′ N	54° 16′ E	...	...	...	...	Ditto ditto. Course N 75° E. Distance 230 miles.
	1 P.M.	...	...	29·792	86·2	SE	...	At 2 P.M. light variable winds and showery.
	8 P.M.	...	...	...	...	SE	...	Steady breeze. Cloudy with passing showers.
	12 P.M.	...	...	...	...	SE	...	Ditto ditto.
S. Cypromene .	1 A.M.	...	...	...	...	S	...	
	4 A.M.	...	...	...	...	SSW	...	Moderate breeze and clear sky.
	Noon	13° 33′ N	68° 10′ E	29·779	...	SSW	...	Light breeze and fine weather. Course N 37° E. Distance 115 miles.
	4 P.M.	...	...	...	...	SSW	...	Light breeze and fine weather.
	8 P.M.	...	...	...	...	SSW	...	Light breeze and clear sky.
	Midnight.	...	...	...	...	SSW	...	Moderate breeze and cloudy weather.
S. Deva Gangadur	5 A.M.	...	...	...	...	E	...	Much thunder and lightning, with a squall of wind and rain from the eastward.
	Noon	14° 4′ N	64° 15′ E	29·794	...	NNW	...	Course N 67° E. Distance 82 miles.
	2 P.M.	...	...	...	...	N	...	Light breeze with showers of rain.
	Midnight.	...	...	...	...	Variable	...	Wind very unsettled in force and direction.
S.S. Ellora .	4 A.M.	...	...	29·869	84·0	NNW	...	Light breeze. Sky cloudy.
	8 A.M.	...	...	29·916	85·0	...	...	Moderate breeze and fine weather.
	Noon	21° 59′ N	68° 35′ E	29·906	85·0	...	...	Course NW by $\frac{1}{2}$ W. Distance 179 miles.
	1 P.M.	...	...	...	...	W	...	
	4 P.M.	...	...	29·852	83·0	W	...	Moderate breeze and fine weather.
	8 P.M.	...	...	29·944	82·0	W	...	Light breeze. Sky cloudy.
	Midnight.	...	...	29·896	85·0	W	...	Ditto ditto.
S. Exporter . .	Noon	0° 22′ N	59° 30′ E	...	...	S	...	Light wind, clear weather with occasional passing squalls.
	1 P.M.	...	...	...	...	S	...	Light southerly wind and frequent rain squalls.
S. Iris . .	4 A.M.	...	...	...	...	S	...	Light breeze; hazy.
	Noon	0° 22′ N	63° 51′ E	...	...	ENE	...	Smart breeze, cloudy with passing showers. Course N 60° W. Distance 127 miles.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"				
S. Iris—contd.	2 P.M.	...	...	...	...	ENE	...	Moderate breeze, cloudy.
	4 P.M.	...	...	...	...	SSE	...	
	8 P.M.	...	...	...	...	S	...	
	Midnight.	...	...	...	...	S	...	Light breeze, hazy.
S. Mistley Hall	1 A.M.	...	...	29·830	...	SW	...	Strong breeze and squally.
	8 A.M.	...	...	...	...	SW	...	Moderate breeze with passing showers.
	Noon	6° 12′ N	56° 44′ E	...	...	SW	...	Ditto ditto. Course N 38° E. Distance 187 miles.
	1 P.M.	...	...	29·850	...	SW to W		
	4 P.M.	...	...	...	...	SW to W	...	Fresh breeze and squally.
	10 P.M.	...	...	...	...	SW	...	Moderate breeze and cloudy. Thunder and lightning to the westward.
S. Queen's Cliff	10 A.M.	...	...	...	...	SW	...	Sudden shift of wind from SE to SW, with heavy rain; overcast.
	Noon	0° 12′ N	52° 51′ E	...	...	...	...	Course N 23° E. Distance 117 miles.
	2 P.M.	...	...	...	...	S	...	Strong breeze and overcast sky.
	8 P.M.	...	...	...	...	SSE	...	Fresh breeze and cloudy.
	Midnight.	...	...	...	...	SSE	...	Ditto ditto.
S. Slieve More	6 A.M.	...	...	...	...	S	...	
	Noon	1° 20′ N	62° 30′ E	29·850	...	S	...	At 4 P.M. clear. At 8 P.M. light breeze and clear. Course N 25° W. Distance 101 miles.
S.S. Wheatfield	1 A.M.	...	...	...	...	NW	...	Light breeze and fine weather; passed the Perim Light at 3·40 A.M.
	Noon	12° 15′ N	44° 49′ E					
	6 P.M.	...	...	...	...	ESE	...	
	12 P.M.	...	...	...	...	...	...	Light breeze and fine weather.

The distribution of barometric pressure and the character of the winds and weather are shown by the Chart for the day, Plate XXVI. The highest pressure is in the south-west corner, where the isobar of 29·9 runs in a south-easterly direction from near Magadoxo, on the coast of Africa, across to the equator in Long. 56° E; and the lowest pressure is in the extreme north, where the isobar of 29·7 runs across from east to west, passing near Karachi, giving a difference of only two-tenths of an inch from north to south on the western side of the Arabian Sea, and little more than one-tenth on the eastern side, from Karachi to Galle. The isobar of 29·8 runs across the middle of the Arabian Sea from Socotra to Karwar, bending southward in the eastern half, thus indicating the incipient formation of an area of abnormally low pressure about Lat. 14° N and Long. 67° E, where the barometer was about ·07″ below the normal height for the time of the year. On the east side, along the coast of India from Galle to Calicut, the pressure

was two or three hundredths of an inch below the normal, but farther north, between Karwar and Karachi, it was from ·01″ to ·03″ above it. On the west side, as far as can be inferred from the observations, it appears to have been slightly below the normal.

Near the equator, and between the African coast and Long. 64° E, the trade wind blew steadily from south, and more strongly near the coast than farther to the east. The *Iris* near the equator in Long. 64° E, had variable winds and passing showers in the day-time, and a steady light breeze from south during the night. Farther north, between Lats. 4° and 6° N the winds had already veered to south-west, from which direction they blew steadily with the force of a moderate breeze. Still farther north, in Lat. 14° N, the winds appear to have been light and variable. On the west coast of India they were north-westerly from Bhuj to Calicut, but in Ceylon they were south-westerly like the winds in the same latitude in the western half of the sea area. The *Hindustan*, in about Lat. 1° S and Long. 55° E had steady south-easterly breezes. There is no doubt therefore that on the 25th, before the formation of the cyclonic vortex, the south-east trade wind extended across the equator as far as about 8° N Lat., veering gradually from SE in southern latitudes to S on the equator, and to SW as it passed farther and farther northward.

Along the west coast of India, from Ratnagiri to Karachi, fine clear weather prevailed, but from Karwar to Galle the skies were cloudy or overcast, and an inch of rain had fallen at Cochin during the previous twenty-four hours. In the central part of the sea area the weather appears to have been clear and fine, but in the western part cloudy rainy weather prevailed along a broad band running in a north-easterly direction from Zanzibar to Lat. 14° N, Long. 64° E. In the northern portion of this band there was much thunder and lightning.

1881, May 26.—The meteorological data for the 26th May are contained in the following tabular statements:—

TABLE XIII.—*10 A.M., 26th May 1881.*

Station.	Barometer.	Change in 24 hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity mean of day.					
					Miles per hour.	°	Per cent.	0 to 10		
Zanzibar	30·″081	+·″009	+·″014	SW	3	78·8	82	4	...	
Aden	29·822	+·033	—·010	Calm	7	91·1	68	...	...	
Bushire	·631	—·014	—·029	NE	8	99·7	39	...	...	
Karachi	·734	+·014	+·037	SW	18	89·0	66	0	...	Strong wind.
Bhuj	·751	+·017	+·049	WNW	13	93·2	46	0	...	
Rajkot	·762	+·007	+·034	W	13	94·1	42	0	...	
Surat	·859	+·065	+·081	W	14	93·5	46	0	...	
Bombay	·844	+·016	+·029	WNW	10	89·0	64	5	...	Slight sea.
Ratnagiri	·815	+·003	+·008	NW	...	91·1	55	0	...	
Karwar	·859	+·002	+·015	W	...	88·0	64	4	...	Moderate wind
Mangalore	·869	+·016	+·016	NE	4	84·9	79	10	0·09	
Calicut	·880	+·029	+·000	Calm	8	82·6	78	5	0·34	d. r.
Cochin	·895	+·034	+·007	N	1	83·5	85	10	3·06	o. r.
Colombo	·882	+·024	—·006	WSW	11	85·5	74	9	...	f.
Galle	·877	+·017	—·001	NW	10	84·0	87	8	0·01	Strong wind.

TABLE XIV.—*26th May 1881.*

NAME OF VESSEL.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	WIND. Direction.	WIND. Force.	REMARKS.
				″	°			
S. Berengaria .	Noon	16° 23′ N	66° 11′ E	29·750	...	NE	...	Light breeze backing from ENE to NE; fine weather. Very heavy increasing sea from SE; course N 54° E. Distance 49 miles.
	1 P.M.	...	...	...	...	...	...	Moderate breeze and clear.
	10 P.M.	...	...	...	...	...	...	Squally.
S. Braidwood .	10 A.M.	...	...	...	...	E	...	
	Noon	0° 15′ N	55° 10′ E	...	...	...	...	
	2 P.M.	...	...	...	...	SE	...	Moderate breeze. Overcast and threatening squalls.
	Midnight	...	...	...	...	SSE	...	Fine breeze with slight showers.
S. British Crown .	Noon	6° 12′ N	59° 50′ E					
	1 P.M.	...	...	...	...	SW to W	...	Moderate breeze and cloudy weather.
	10 P.M.	...	...	...	...			Overcast sky.
	Midnight	...	...	...	...	SW ½ S	...	Squally, with lightning. Shipping a great deal of water on deck.
S. Choice . .	Noon	0° 1′ N	53° 6′ E	...	...	...	...	
	1 P.M.	...	...	...	...	SSE	...	Strong breeze and fine weather.
S.S. Clan Alpine .	1 A.M.	...	...	29·792	85·8	NE	...	Light winds. Lightning to the SE.
	4 A.M.	...	...	...	...	Variable	...	Cloudy.
	8 A.M.	...	...	...	...	SE	...	Light winds. Gloomy weather.
	Noon	15° 51′ N	57° 59′ E	...	...	SE	...	Ditto ditto. Course N 76° E. Distance 223 miles.
	1 P.M.	...	...	29·792	87·2	SE	...	
	4 P.M.	...	...	...	...	SE	...	Steady breeze and fine clear weather.
	9 P.M.	...	...	...	...	SSE	...	Light breeze and cloudy weather.
	Midnight.	...	...	...	...	SSE	...	Ditto ditto.
SS. Clandon .	3 P.M.	Near	Aden	...	...	Calm	...	Light variable winds and hot.
	10 P.M.	...	...	...	...	WSW	...	Ditto ditto.
S. Cypromene .	4 A.M.	...	...	...	...	SSW	...	Moderate breeze and cloudy weather.
	Noon	14° 35′ N	69° 30′ E	29·819	...	SSW	...	Moderate breeze and passing showers. Course N 51° E. Distance 98 miles.
	1 P.M.	...	...	...	...	S	...	Fine clear weather.
	8 P.M.	...	...	...	...	S	...	Fine clear weather; heavy swell from SW.
	Midnight.	...	...	...	...	S	...	Fine breeze and cloudy weather. Heavy swell from SW.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				°	°			
S. Deva Gangadur	2 A.M.	...	...	...	...	...	...	Wind increasing.
	8 A.M.	...	...	...	...	...	...	Heavy cross sea.
	Noon	13° 58′ N	65° 48′ E	29·695	...	...	...	Moderate gale with heavy showers. Course S 84° E. Distance 91 miles.
	2 P.M.	...	...	...	...	NW	...	Gale increasing. Ship rolling heavily and taking large quantities of water on deck.
	Midnight.	...	...	...	...	...	...	Gale increasing with heavy rain squalls.
S.S. Elora	4 A.M.	...	...	29·932	83·0	W		
	8 A.M.	...	...	29·968	84·0	W	...	
	Noon	24° 39′ N	66° 56′ E	29·961	83·0	W	...	
S.S. Eschol	1 P.M.	...	...	...	...	Variable	...	Light variable airs with hot sultry weather.
	Midnight.	...	...	...	...	SW	...	Ditto ditto.
S. Exporter	5 A.M.	...	...	...	...	W	...	Wind changed to west, blowing fresh.
	7 A.M.	...	...	...	...	NW	...	Wind moderate.
	Noon	2° 33′ N	59° 54′ E	...	...	...	...	
	1 P.M.	...	...	...	...	S	...	
S. Hindustan	4 A.M.	...	...	...	...	SE by S	...	Wind very steady.
	8 A.M.	...	...	...	...	...	...	Fresh breeze and clear weather.
	Noon	1° 7′ N	54° 23′ E	...	...	...	...	Steady breeze and clear weather. Course N 39° E. Distance 159 miles.
	1 P.M.	...	...	...	...	SE by S	...	Fine clear weather.
	4 P.M.	...	...	...	...	SE by S	...	Very steady breeze and clear weather.
	8 P.M.	...	...	...	...	SE by S	...	Ditto ditto.
	Midnight.	...	...	...	...	SE by S	...	Steady breeze and clear weather.
S. Iris	2 A.M.	...	...	...	...	S	...	Light breeze, hazy, passing showers.
	Noon	1° 54′ N	63° 47′ E	29 877	...	...	...	Course N 30°W. distance 92 miles.
	2 P.M.	...	...	...	...	S	...	Light breeze. Showers of rain.
S. Mistley Hall	1 A.M.	...	...	29·850	...	SW by S	...	Fresh breeze and cloudy weather. Ship rolling, and straining heavily.
	Noon	8° 12′ N	59° 18′ E	...	...	...	...	Ditto ditto. Course N 41° E. Distance 182 miles.
	1 P.M.	...	...	29·830	...	SW	...	Upper main topsail carried away at 3 P.M.
S. Queen's Cliff	4 A.M.	...	...	...	...	S	...	
	Noon	2° 19 N	54° 44′ E	...	...	S	...	Light breeze and clear sky. Course N 34° E. distance 158 miles.
	2 P.M.	...	...	...	...	SSW	...	Light breeze and clear sky.
	Midnight.	...	...	...	...	...	...	Fresh breeze, squally.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. Slieve More .	1 A.M.	...	...	...	...	SE	...	Light breeze and clear weather.
	8 A.M.	...	...	...	...	SE	...	Increasing breeze and clear weather.
	Noon	2° 52′ N	61° 41′ E	29·900	...	S	...	Brisk breeze and cloudy weather. Course N 28° W. Distance 104 miles.
	1 P.M.	...	...	...	...	SSW	...	
	8 P.M.	...	...	...	...	SSW	...	Light breeze and clear weather.
S.S. Tebe . .	Noon	12° 30′ N	44° 25′ E	29·733?	...	NW	2	
S.S. Tenasserim .	4 A.M.	Karachi to Karwar.		29·779	82·7	SW	3	b. c. Slight westerly swell.
	8 A.M.	...	...	29·893	84·7	Variable	1	b. c. v. Fine weather. Smooth sea.
	Noon	16° 9′ N	72° 46′ E	29·841	85·7	SW	1	b. c. SW swell. Fine weather. Course S 35° E. Distance 216 miles.
	4 P.M.	...	...	29·848	86·7	SW	2	b. v.
	8 P.M.	...	...	29·821	85·7	SWbyW	2	b. c. l. Fine weather and smooth sea.
	Midnight.	...	...	29·821	85·7	SW	1	b. c. Light SW swell.
S.S. Wheatfield .	1 A.M.	...	...	...	...	ESE	...	Light breeze and fine weather.
	7 A.M.	...	...	...	...	Calm	...	
	Noon	13° 9′ N	47° 44′ E	...	...	...	...	
	5 P.M.	...	...	...	...	SW	...	Light breeze and fine weather.
	8 P.M.	...	...	...	...	Variable	...	Ditto ditto.

The chart for the day, Plate XXVII, shows that the general distribution of pressure round the shores of the Arabian Sea and near the equator was nearly the same as on the 25th, the only change having been a slight and nearly uniform rise. In the middle of the Arabian Sea, however, the pressure had fallen about a tenth of an inch, forming a slight but distinct centre of low pressure about Lat. 13° 40′ N, and Long. 66° 54′ E where the barometer had gone down to a little below 29·7 inches. The normal or average pressure for the 26th May, in this position, is about 29·85. The actual pressure at noon on that date was therefore only a little more than ″·15 below the normal, and yet this small depression was sufficient to give rise to decided cyclonic indications. The *S. Deva Gangadur*, about 50 miles from the centre, and on the west side of it, had a moderate gale from NW, with heavy showers of rain. Both wind and rain increased as the day advanced, and the barometer fell rapidly. The *S. Berengaria*, about 200 miles to the north-north-west of the centre, had a light breeze from N E, and a very heavy increasing sea from SE, which was doubtless produced by the strong SE wind on the east side of the centre. The *S. Cypromene*, about 200 miles to the east-north-east of the centre, had a moderate breeze from SSW and S, and a heavy swell from SW, with cloudy weather and passing showers. It should be noticed that both the last-mentioned vessels reported the swell to be from a direction several points to the right of that from which the wind blew. In the south of the area the wind system had moved bodily northward, the wind now being from SE on the equator, from due south on the parallel of Lat. 2°

N, and from SW between Lat. 6° and 8° N. It had at the same time increased in strength and was now blowing with an average force of 4·4 of Beaufort's scale, that is, between a moderate and a gentle breeze. On the previous day the average force was 3·7. On the west coast of India the winds were light and chiefly north-westerly. In Ceylon they were light and westerly. In the south-west of the sea area the weather had cleared considerably since the 25th, but had become more cloudy and rainy in the neighbourhood of the barometric depression and on the Malabar Coast.

1881, May 27.—The meteorological information for the 27th May is contained in the two following tables, and much of it is graphically represented on the chart for the day, Plate XXVIII.

TABLE XV.—*10 A.M., 27th May 1881.*

Station.	Barometer.	Change in 24 hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity mean of day.					
	"	"	"		Miles per hour.	°	Per cent.	0 to 10.	"	
Zanzibar . .	30·079	—·002	+·009	SW	4	77·5	87	7	0·03	
Aden . .	29·777	—·045	—·052	SSE	7	89·6	65	...	...	
Bushire . .	·679	—·002	—·025	N	9	97·7	38	...	...	
Karachi . .	·721	—·016	+·028	SW	17	89·0	73	1	...	
Bhuj . . .	·726	—·025	+·031	WSW	13	92·2	50	0	...	
Rajkot . .	·757	—·005	+·033	W	15	90·3	47	0	...	
Surat . . .	·795	—·064	+·020	W	15	90·5	60	0	...	
Bombay . .	·840	—·004	+·028	SW	8	87·9	61	2	...	
Ratnagiri . .	·819	+·004	+·013	S	...	89·6	58	1	...	
Karwar . .	·841	—·018	+·002	SW	...	85·1	76	6	0·07	Fresh wind.
Mangalore . .	·893	+·024	+·040	E	4	78·0	91	10	0·34	
Calicut . .	·893	+·013	+·013	N	9	79·6	86	6	0·58	d. r.
Cochin . .	·891	—·004	+·002	NNW	2	85·0	74	6	0·50	
Colombo . .	·849	—·033	—·039	WSW	14	87·5	69	2	...	
Galle . .	·847	—·030	—·031	NW	11	84·0	87	3	0·61	Strong wind.

TABLE XVI.—*27th May 1881.*

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Wind.	
				"	°			
S. Africa . .	Noon	16° 2′ N	66° 55′ E	29·809?	...	NE	...	Fresh increasing breeze and cloudy weather. Barometer falling. Course SE by E.
	6 P.M.	...	...	29·799?	...	NNE	...	Increasing breeze, squalls and rain. Lightning in E and ESE horizon.
	Midnight.	...	...	29·785?	...	...	...	

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. Berengaria	5 A.M.	...	...	...	...	...	...	Squalls increasing.
	Noon	15° 22′ N	67° 19′ E	29·650	...	...	...	Moderate increasing gale. Sea more from Eastward Course S 49° E. Distance 89 miles.
	1 P.M.	...	...	...	...	ENE	...	Heavy squalls and rain.
	10 P. M.	...	...	...	...	NNW	...	
S. S. Bessie Morris	1 A.M.	...	...	29·517	84·5	ENE	2	Light breeze and dark cloudy weather. Lightning to the E and SE.
	6 A.M.	...	...	29·621	...	NW	...	
	8 A.M.	...	...	...	...	W	...	Squally with rain and thunder and lightning.
	Noon	13° 51′ N	52° 46′ E	29·726	80·5	NNW	...	High confused sea. Course N 82° E. Distance 216 miles.
	4 P.M.	...	...	...	...	NNE	...	
	8 P.M.	...	...	...	...	SE	2	
	Midnight.	...	...	...	...	SSW	...	Fresh breeze and fine weather.
S. Braidwood	2 A.M.	...	...	...	...	SSE	...	Squalls and heavy showers.
	10 A.M.	...	...	...	...	S	...	Do. do.
	Noon	2° 23′ N	55° 40′ E	...	...	...	...	Do. do.
	2. P.M.	...	...	...	...	SE	...	Moderate breeze and heavy squall. Wind hauled to the SW with thunder and lightning.
	Midnight.	...	...	...	...	...	,,	Moderate breeze and squally.
S. British Crown	Noon	7° 40′ N	61° 15′ E	...	...	SW ½ S	...	Squalls at 11 A.M.
	2 P.M.	...	...	...	...	SW by S	...	Fresh breeze, cloudy and gloomy.
	Midnight.	...	...	...	...	...	...	Overcast sky.
S. Choice	2 A.M.	...	...	...	...	SSE	...	
	Noon.	2° 15′ N	55° 2′ E	29·965	...	SSE	...	Course N 32° E. Distance 159 miles.
	1 P.M.	...	...	...	...	SE	...	Strong breeze and cloudy weather
	3 P.M.	...	...	...	...	...	...	Squally.
	8 P.M.	...	...	...	...	SW	...	Strong breeze and showery weather.
	9 P.M.	...	...	...	...	SW	...	Fresh breeze and overcast sky.
S.S. Clan Alpine	1 A.M.	...	...	29·792	88·2	SW	...	Light wind and cloudy weather. Heavy SW swell.
	8 A.M.	...	...	...	...	SSE	...	Light airs and fine clear weather.
	10 A.M.	...	...	...	...	Calm	...	
	Noon	16° 44′ N	61° 58′ E	...	...	...	...	Fine clear weather. Course N 76° E.; distance 240 miles.
	1 P.M.	...	...	29·672	83·8	NW	...	
	4 P.M.	...	...	...	...	NW	...	Light breeze and clear weather.
	8 P.M.	...	...	...	...	...	...	Moderate breeze and cloudy weather.
	Midnight	...	...	29·512	...	NNW	...	Moderate breeze and overcast sky.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S.S. Clandon .	1 A.M.	...	...	...	...	SW	...	Light breeze and clear weather.
	9 A.M.	...	...	...	...	WSW	...	Ditto ditto.
	Noon	13° 0′ N	48° 25′ E	...	...	WSW	...	Ditto ditto.
	5 P.M	...	...	...	...	Var.	...	
	8 P M.	...	...	...	...	...	...	Fresh breeze and cloudy weather.
	Midnight.	...	...	...	...	Var.	...	Light airs.
S. Cypromene .	4 A.M.	...	...	...	...	S	...	Moderate breeze and passing showers.
	Noon	15° 57′ N	70° 41′ E	...	...	S	...	Pleasant breeze and fine weather; course N 39° E. Distance 106 miles.
	2 P.M.	...	...	...	...	...	...	Squally with heavy rain.
	Midnight.	...	...	...	...	...	...	Pleasant breeze and fine weather.
S. Deva Gangadur	2 A.M.	...	...	...	...	...	...	In a violent squall, the lower maintop sail blew away.
	10 A.M.	...	...	...	...	...	...	Heavy sea breaking over the vessel, washing away bulwarks and bursting open the cabin doors, filling cabin full of water.
	Noon	13° 45′ N	66° 15′ E	29·496	...	...	...	Course N 67° E. Distance 36 miles.
	2 P.M.	...	...	...	...	NW	...	Blowing a gale with heavy squalls of wind and rain.
	4 P.M.	...	...	...	...	Var.	...	
	6 P.M.	...	...	...	...	...	...	Bent storm try-sail; unable to bend another on account of the violence of the squalls.
S.S. Ellora . .	8 A.M.	...	...	29·938	84·0	...	...	Moderate breeze and fine weather.
	Noon	23° 43′ N	66° 59′ E	30·043	82·0	...	...	Ditto ditto westerly swell; course S 67° E. distance 65 miles.
	4 P.M.	...	...	29·936	85·0	SW	...	Moderate breeze and fine weather.
	8 P.M.	...	...	30·078	84·0	SW	..	Light breeze and fine weather.
S.S. Eschol . .	8 A.M	...	...	...	...	SW	...	
	Noon	13° 12′ N	47° 49′ E	...	...	...	...	Moderate breeze.
	2 P.M.	...	...	...	...	SW	...	Moderate breeze with hot weather.
	Midnight.	...	...	...	...	Var.	...	Lightning and light breeze.
S. Exporter . .	1 A.M.	...	...	...	...	S	...	
	Noon	4° 9′ N	60° 12′ E	...	...	S	...	Light southerly wind and cloudy weather.
S. Hindustan .	8 A.M.	...	...	...	...	SSE	...	
	Noon	3° 2′ N	56° 11′ E	...	...	...	...	Very steady breeze and clear weather; course N 43° E. Distance 157 miles.
	1 P.M.	...	...	...	...	SSE	...	Fresh breeze and fine weather.
	4 P.M.	...	...	...	...	...	...	Steady breeze and fine weather.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				″	°			
Hindustan—contd	8 P.M.	...	...	...	...	...	...	Commences to look squally in SW. Lightning round to the westward.
	Mid-night.	...	...	...	...	S	...	Looking squally in the westward.
S.S. Inchulva	1 A.M.	...	...	...	...	SE to S	...	Fine weather, clear sky; swell from S E.
	5 A.M.	...	...	...	...	...	...	Light airs.
	Noon	...	...	...	...	W	...	Moderate wind; heavy SW swell, course N 60° E. Distance 210 miles.
	4 P.M. to 8 P.M.	...	...	...	...	...	...	Sky overcast; sea as before.
	8 P.M. to Mid-night.	...	...	...	...	SW to NW.	...	Fine weather, wind light.
S. Iris	1 A.M.	...	...	...	...	SSW	...	At 2 A.M., moderate breeze and fine weather.
	Noon	3° 48′ N	63° 31′ E	...	...	...	...	Pleasant breeze and fine weather; course N 8° W; distance 116 miles.
	7 P.M.	...	...	...	...	SW	...	At mid-night pleasant breeze and cloudy weather.
S. S. Mercedes	1 A.M.	...	...	...	...	W	2	Light breeze and a clear sky. Heavy head sea. Course W by S.
	6 A.M.	...	...	...	...	S	2	
	10 A.M.	...	...	...	...	SE	2	
	Noon	18° 18′ N	70° 29′ E	...	...	SE	2	Fine weather; continuous head sea; course S 75° W. Distance 138 miles.
	8 P.M.	...	...	...	...	SE	4	Fresh breeze.
S. Mistley Hall	1 A.M.	...	...	29·830	...	SW by W	...	Moderate breeze and clear weather.
	Noon	10° 39′ N	61° 20′ E	...	...	...	...	Ditto ditto
	1 P.M.	...	...	29·810	...	...	...	Course N 39° E. Distance 192 miles.
	6 P.M.	...	...	29·770	...	...	...	Every appearance of heavy weather; at 6-30 P.M. strong squall with heavy rain, thunder and lightning.
	10 P.M.	...	...	29·750	...	...	...	
S. Queen's Cliff	4 A.M.	...	...	...	...	SW	...	
	Noon	4° 14′ N	56° 22′ E	...	...	...	...	Strong breeze and squally; course N 40° E. Distance 151 miles.
	2 P.M.	...	...	...	...	SW	...	Strong breeze.
	Mid-night	...	...	...	...	...	...	Strong breeze with squalls and heavy showers.
S. S. Rohilla	1 A.M.	...	...	...	...	NW		At 2 A.M. vivid lightning to SE.
	4 A.M.	...	...	29·706	87·0	N	...	Moderate unsteady wind; overcast; lightning to SE.
	6 A.M.	...	...	...	...	N	...	Fresh wind.
	8 A.M.	...	...	29·828	86·0	NE	...	Overcast; rising sea; lightning to SW.
	Noon	14° 11′ N	53° 58′ E	29·723	91·0	...	...	Moderate breeze; overcast with slight rain at times. Course N 75° E. Distance 297 miles.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Rohilla.—contd.	4 P.M.	...	...	29·649	86·0	...	...	Steady breeze. Fine clear weather.
	8 P.M.	...	...	29·711	85·0	SE	...	Fresh increasing breeze and cloudy weather.
	Midnight	...	...	29·761	85·0	S	...	Fresh breeze and overcast sky with rain. Rising sea.
S. S. Sestos	1 A.M.	...	...	...	...	W	...	
	4 A.M.	...	...	...	...	W	...	Light airs from west. Fine clear weather. Ship tumbling about a good deal.
	Noon	18° 58′ N	70° 51′ E	29·724	79·7	...	...	Faint airs; hot weather. Course N 86° W. Distance 131 miles.
	1 P.M.	...	...	...	...	Calm	...	
	4 P.M.	...	...	...	...	SE	...	Very light wind; weather very hot.
	8 P.M.	...	...	...	...	SE	...	Breeze freshening. Ship lurching and rolling about heavily in the confused and high swell.
	Midnight	...	...	...	...	ESE	...	Ditto ditto
S. S. Sirdhana	4 A.M.	...	...	29·746	81·7	W	...	Moderate breeze; strong south-westerly swell; ship rolling heavily.
	8 A.M.	...	...	29·771	83·7	...	...	Light wind; south-westerly swell; ship rolling very heavily.
	Noon	20° 24′ N	70° 39′ E	29·737	88·7	W	...	Light airs; south-westerly swell; ship rolling heavily.
	4 P.M.	...	...	29·800	83·7	...	...	No change.
	8 P.M.	...	...	29·771	83·7	...	...	Ditto.
	Midnight	...	...	29·793	82·7	...	...	Ditto.
S. Slieve More	1 A.M.	...	...	...	...	S	...	
	4 A.M.	...	...	...	...	...	...	Increasing breeze and cloudy weather.
	7 A.M.	...	...	...	...	SW	...	At 8 A.M brisk breeze and cloudy weather.
	Noon	5° 9′ N	61° 58′ E	29·860	89·0	SW	...	Ditto ditto Course N 6° E. Distance 143 miles.
	4 P.M.	...	...	...	...	...	...	Brisk breeze and cloudy weather.
	9 P.M.	...	...	...	...	...	...	Cloudy weather with lightning to N & NE.
	Midnight	...	...	...	...	...	...	Fresh breeze and cloudy weather.
S. S. Tebe	4 A.M.	...	...	29·718	...	NW	2	
	8 A.M.	...	...	29·708	...	NW	2	
	Noon	12° 55′ N	45° 46′ E	29·713	...	NW	2	
	4 P.M.	...	...	29·699	...	NW	2	
	8 P.M.	...	...	...	...	SW	2	
	Midnight	...	...	...	...	SW	2	

Name of Vessel.	Hours.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
S. S. Wheatfield	1 A.M.	...	...	...	...	Variable	...	Light airs, and fine weather.
	Noon	13° 58′ N	51° 11′ E	...	...	...	...	
	8 P.M.	...	...	...	...	N	...	Light breeze and cloudy sky; lightning to the SE.
	Mid-night	...	...	...	...	NE	...	Light breeze and overcast sky.

The pressure fell slightly along the coast of India to the north of Bombay and also in Ceylon, but rose a little along the intermediate coast line. It also fell considerably at Aden. When these changes had taken place, the pressure was still two or three hundredths of an inch above the normal along the whole western coast of India, but in Ceylon it was from three to four hundredths below it, and at Aden it was five hundredths below. In the south-western portion of the sea area the pressure had changed but little since the previous day. If anything, it had risen slightly. But in the middle of the Arabian Sea the barometric depression had assumed much larger proportions than on the 26th, the pressure near the centre having fallen two-tenths of an inch in twenty-four hours, thereby increasing the diameter of the circular isobar of 29·7 from about 150 miles to about 300 miles, and bringing that of 29·5 into view for the first time, with a diameter of about 90 miles. The position of the centre of the depression was very nearly the same as on the previous day, *viz.*, in Lat. 13° 48′ N, Long. 66° 56′ E. The lowest recorded pressure was about 29″5, as reported by the *Deva Gangadur*, which was about 40 miles to the west of the centre. This is about ·35″ below the average pressure for the time of the year at the position then occupied by the ship. Simultaneously with this fall of the barometer, the wind increased to a gale from NW with violent squalls of wind and rain, raising a heavy sea which washed away the bulwarks, and otherwise damaged the ship. The *Berengaria*, which was about 115 miles to the NNE of the centre, had a moderate and increasing gale from ENE with heavy squalls and rain, and a "sea" from the eastward; while the *Africa*, which was about 160 miles to the N of the centre, farther away than the *Berengaria*, reported a fresh increasing breeze from NE and cloudy weather with a falling barometer, and later in the day squalls and rain with lightning in the E and SE. Outside the storm area, between it and the equator and to the west of the 64th meridian, the trade wind system had again advanced bodily northward, south-easterly winds now extending as far as 3° N Lat., southerly winds to Lat. 4° N, and south-westerly winds farther northward. The strength of these winds had again increased, and they were now blowing with an average force of 4·7. In the Gulf of Aden the winds were light, and variable in direction, but from Long. 52° E to Long. 62° E along the steamer track from Aden to Bombay they were light and northerly. Along the west coast of India from Bombay to Karachi they were light and south-westerly, from Bombay to Mangalore light and variable, and farther south light and north-westerly. Between the coast and the storm area they blew with the strength of a moderate breeze from southerly directions. Around the storm centre the weather was squally and rainy, every vessel within a distance of 300 miles from the centre having reported to that effect. Rain was not exclusively confined to the storm area, however, for it was also reported by several ships to the north

of Socotra, by several others far away to the south-west, about 1,000 miles from the storm centre, and by the *Mistley Hall* in the intermediate region. The last mentioned vessel, when fully 400 miles from the centre, recorded a strong squall, heavy rain, thunder and lightning, and "every appearance of heavy weather." Rain had also fallen during the preceding twenty-four hours along the Malabar Coast and in Ceylon, but none had fallen to the northward of Karwar, where the weather remained fine and clear.

28th May 1881.—The following tables contain the meteorological information for the 28th.

TABLE XVII.—*10 A. M., 28th May 1881.*

Station.	Barometer.	Change in 24 hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity mean of day.					
	"	"	"		Miles per hour.	°	Per cent.	0 to 10.	"	
Zanzibar	30·076	—·013	+·003	WSW	4	77·2	87	1	0·02	
Aden	29·736	—·041	—·090	ENE	4	90·2	75	...	...	
Bushire	·738	+·059	+·040	NW	8	90·8	54	...	...	
Karachi	·727	+·006	+·038	SSW	?	90·0	65	?	?	
Bhuj	·746	+·020	+·055	SW	11	91·7	45	0	...	
Rajkot	·759	+·002	+·038	WNW	17	92·4	44	0	...	
Surat	·799	+·004	+·027	W	12	92·5	48	0	...	
Bombay	·796	—·044	—·014	SSW	10	89·0	64	4	...	Sea rather rough.
Ratnagiri	·819	—·025	+·015	SSW	...	88·0	61	2	0·05	Sea very high.
Karwar	·853	+·012	+·010	SW	...	83·1	78	6	0·40	Sea rough.
Mangalore	·875	—·018	+·022	SSW	3	84·9	76	5	0·05	
Calicut	·889	—·004	+·009	SSW	5	81·7	86	3	0·04	Sea very rough.
Cochin	·898	+·007	+·009	NNW	2	86·0	68	2	...	
Colombo	?	?	?	SW	10	86·5	69	2	...	
Galle	·888	+·041	+·010	NW	10	85·0	87	4	0·02	

TABLE XVIII.—*28th May 1881.*

Name of Vessel.	Hours.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. Africa	6 A.M.	...	...	29·659?	...	...	...	Wind and squalls increasing in violence, and all signs of bad weather, bore away about 30 miles to SW and SSW to avoid centre of cyclone.
	Noon	15° 10′ N	66° 50′ E	29·679?	...	NNW	...	Ship becoming unmanageable, hove-to on port tack. Wind increasing in violence.

Name of Vessel.	Hours.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. Africa—contd.	4 P.M.	...	...	29·609?	...	...	...	Heavy gale.
	6 P.M.	...	...	...	...	...	...	Storm increasing with tremendous squalls; sea getting more confused.
	7 P.M.	...	...	29·449?	...	NW	...	Wind changing more towards W and SW.
	8 P.M.	...	...	29·159	...	...	...	
	9 P.M.	...	...	29·109	...	...	...	
	9-30 P.M.	...	...	28·909	...	...	...	
	10 P.M.	...	...	28·799	...	SW	...	
	11-30 P.M.	...	...	28·859	...	...	...	
	Midnight.	...	...	...	...	...	...	Wind blowing a tremendous hurricane. Sea mountainous from all directions of the compass. Continual lightning all round and loud peals of thunder. Blinding rain; barometer rising.
S. Berengaria	6 A.M.	...	...	29·450	...	NNE	...	
	8 A.M.	...	...	29·350	...	...	...	Wind and sea increasing.
	9 A.M.	...	...	29·250	...	...	...	Wind strong and squally.
	9-30 A.M.	...	...	29·150	...	...	...	Fore lower topsail carried away.
	10 A.M.	...	...	...	...	...	...	Kept ship away before the wind. Heavy rain.
	Noon	14° 49′ N	67° 29′ E	29·302	...	W	...	Fierce gale gradually backing to southward. Course N 20° E. Distance 36 miles.
	1 P.M.	...	...	...	...	SW	...	Fierce gale blowing as hard as ever; heavy sea. Ship labouring and shipping much water.
	Midnight.	...	...	...	...	...	...	Gale moderating.
S.S. Bessie Morris	1 A.M.	...	...	29·726	80·5	SW	3	Moderate breeze and cloudy with high confused sea.
	4 A.M.	...	...	...	...	SW	4	
	9 A.M.	...	...	...	...	SW	5	
	Noon	14° 23′ N	56° 36′ E	29·818	83·5	SW	5	Brisk breeze and fine weather. Course N 82° E. Distance 225 miles.
	1 P.M.	...	...	...	...	SW	5	Strong breeze and heavy swell from SW.
	6 P.M.	...	...	...	...	SW by W	5	
S Braidwood	2 A.M.	...	...	...	...	S	...	
	10 A.M.	...	...	...	...	SW	...	
	Noon	4° 22′ N	56° 40′ E	...	...	...	...	Course N 36° E.
	2 P.M.	...	...	...	...	SW	...	Fine clear weather.
S. British Crown	6 A.M.	...	...	...	...	WSW	...	Squall at 0-30 A.M.
	Noon	9° 5′ N	62° 41′ E	...	...	...	...	Fresh breeze and squally weather with heavy sea.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. British Crown—contd.	2 P.M.	...	...	...	...	WSW	...	Strong breeze and squally weather.
	8 P.M.	...	...	...	...	...	...	Heavy tumultuous sea. Ship labouring considerably.
	Midnight	...	...	...	...	W	...	Same weather. Ship rolling rails under at intervals.
S. Choice . .	Noon	4° 31′ N	56° 30′ E	29·965	...	SW	...	At 1 P.M. strong breeze and overcast sky.
	4 P.M.	...	...	...	...	SW by W	...	Ditto ditto.
	8 P.M.	...	...	...	...	...	...	Strong breeze and squally weather.
S.S. Clan Alpine .	1 A.M.	...	...	29·672?	83·2	NW	...	Moderate breeze and cloudy weather.
	5 A.M.	...	...	...	...	NNW	...	Smart breeze and smooth sea.
	8 A.M.	...	...	29·482?	...	N	...	High southerly sea. Threatening appearance to southeastward.
	9 A.M.	...	...	...	...	NNE	...	Strong breeze with heavy rain. Squalls at 10 A.M.
	Noon	17° 42′ N	65° 50′ E	...	...	NNE	...	Cloudy weather. Course N 76° E. Distance 228 miles.
	1 P.M.	...	...	29·462?	82·0	NE	...	Fresh gale with heavy rain, squalls and high cross sea.
	4 P.M.	...	...	...	...	ENE	...	Wind suddenly shifted to ENE in a hard squall.
	8 P.M.	...	...	29·332?	...	E by N	...	Fresh gale and overcast sky. Less sea.
	Midnight.	...	...	29·292?	...	E by N	...	Fresh gale with hard squalls and rain.
S.S. Clandon .	1 A.M.	...	...	...	...	SW	...	Light breeze and clear weather.
	9 A.M.	...	...	...	...	WSW	...	Ditto ditto.
	Noon	13° 0′ N	48° 25′ E	...	...	WSW	...	Ditto ditto.
	5 P.M.	...	...	...	...	Variable	...	
	Midnight.	...	...	...	...	...	...	Light variable winds.
S. Cypromene .	Noon	17° 51′ N	72° 10′ E	...	...	S	...	Fine breeze and clear weather; course N 34° E. Distance 138 miles.
S. Deva Gangadur	5 A.M.	...	...	...	...	...	...	Gale moderating.
	Noon	13° 35′ N	66° 40′ E	29·595	...	...	...	Ship rolling very heavily, and taking large quantities of water on deck; course N 79° E. Distance 36 miles.
	2 P.M.	...	...	...	...	W	...	Blowing a moderate gale, with heavy squalls of wind and rain.
	8 P.M.	...	...	...	...	...	...	A heavy sea rolling from the northward, setting the ship to the southward at the rate of 1¼ miles per hour. The ship heading due north, but plunging very heavily.
S. S. Ellora .	4 A.M.	...	...	...	84·0	SW	...	Light wind and fine weather.
	8 A.M.	...	...	...	85·0	Calm	...	Fine weather. Heavy SW swell.
	Noon	20° 59′ N	69° 52′ E	...	86·0	Calm	...	Ditto ditto. Course S 44° E. Distance 228 miles.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Ellora—contd.	4 P.M.	...	...	...	85·0	S	...	Light breeze and heavy southerly swell.
	8 P.M.	...	...	...	82·0	S	...	Ditto ditto.
	Midnight.	...	...	...	82·0	S	...	Ship rolling violently. Moderate breeze with heavy southerly swell.
S. S. Eschol	2 A.M.	...	...	...	...	...	...	Light airs.
	8 A.M.	...	...	...	...	ENE	...	Variable light airs.
	Noon	14° 4′ N	51° 12′ E	29·602	...	...	...	Variable light breeze.
	2 P.M.	...	...	...	...	ENE	...	Light airs with hot sultry weather.
	8 P.M.	...	...	...	...	SE	...	Moderate breeze at 8-30 P.M.
	Midnight.	...	...	...	...	S	...	Moderate breeze with a heavy SW swell.
S. S. Euphrates	4 A.M.	...	...	29·785	81·1	SW	...	Moderate breeze and clear sky.
	8 A.M.	...	...	29·865	87·1	Calm	...	
	Noon	At Cutch	Mandvi.	...	...	...	...	
	4 P.M.	...	...	29·785	81·1	W	...	
	8 P.M.	...	...	29·805	83·1	Calm	...	
	Midnight.	...	...	29·805	79·1	Calm	...	Cloudy weather.
S. Exporter	Noon	6° 55′ N	61° 0′ E	...	...	SW	...	Fresh wind and squally weather.
S. Hindustan	3 A.M.	...	...	...	...	SW by W	...	Wind shifted in a squall from S to SW with heavy rain.
	5 A.M.	...	...	...	...	S	...	Wind shifted back again to the southward.
	8 A.M.	...	...	...	...	WSW	...	Heavy rain.
	9 A.M.	...	...	...	...	WNW	...	
	Noon	4° 55′ N	58° 26′ E	...	...	WSW	...	Thick drizzling rain and strong breeze; course N50°E. Distance 176 miles.
	1 P.M.	...	...	...	...	SW by S	...	Fresh breeze and drizzling rain up to 3 P.M.
	4 P.M.	...	...	...	...	SW	...	Steady breeze and fine clear weather.
	8 P.M.	...	...	...	...	...	...	Strong breeze and cloudy.
	Midnight.	...	...	...	..	SW	...	Strong monsoon with rain.
S. S. Inchulva	1 A.M.	...	...	...	...	SW to NW	...	Moderate breeze. SW sea. Sky partly clouded.
	8 A.M.	...	...	...	...	NW	...	Fresh breeze; SW swell; cloudy weather.
	Noon	16° 36′ N	63° 47′ E	29·694	...	NW	...	Ditto ditto ditto. Course N 60° E. Distance 205 miles.
	6 P.M.	...	...	...	...	W	...	Light wind; heavy swell from SW.
	8 P.M.	...	...	29·674	...	...	...	
	Midnight.	...	...	29·694	...	N	...	Thunder distinct but distant. Very heavy rain. Wind light. Sea as before. Barometer steady.
S. Iris	1 A.M.	...	...	...	...	SW	...	Smart steady breeze and cloudy weather.
	Noon	6° 39′ N	63° 25′ E	29·797	...	SW	...	Ditto ditto. Course N 2° W. Distance 171 miles.

Name of Vessels	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				″	°			
S. Iris—contd.	3 P.M.	...	...	...	...	...	...	Squally.
	9 P.M.	...	...	...	...	WSW	...	Fresh breeze and squally. Lightning in the NW quarter.
S. S. Mercedes	1 A.M.	...	...	...	...	ESE	6	Strong breeze and cloudy weather. A heavy confused sea running. Ship labouring heavily and shipping vast quantities of water.
	5 A.M.	...	...	...	...	E	6	Ditto ditto.
	Noon	17° 41′ N	67° 39′ E	29·784	84·0	E	7	Strong gale with a heavy confused sea from SE; course S 78° W. Distance 174 miles.
	4 P.M.	...	...	...	...	E	8	Violent squalls of wind and rain.
	8 P.M.	...	...	...	...	E by N	8	
	Midnight.	...	...	...	...	ENE	8	
MS. istley Hall	1 A.M.	...	...	29·730	...	WSW	...	Strong freshening breeze and overcast sky.
	4 A.M.	...	...	29·710	...	WSW	...	
	8 A.M.	...	...	29·670	...	W	...	Strong breeze and overcast sky.
	Noon	13° 59′ N	64° 6′ E	29·640	...	W	...	Ditto ditto. Course N 39° E. Distance 212 miles.
	3 P.M.	...	...	...	...	WNW	...	Fresh gale and squally weather.
	6 P.M.	...	...	...	...	...	...	Torrents of rain with terrific squalls.
	8 P.M.	...	...	29·610	...	WNW	...	Freshening gale and squally weather. Ship rolling and straining heavily. Shipping large quantities of water.
	Midnight	...	...	29·570	...	WNW	...	
S. S. Nyanza	3 A.M.	...	...	30·063	75·3	ESE	3 to 4	Moderate breeze and cloudy weather.
	7 A.M.	...	...	30·023	79·3	...	...	Ditto ditto.
	11 A.M.	...	...	30·017	81·3	SE	3 to 4	
	Noon	0° 28′ N	46° 38′ E	...	...	...	...	Moderate breeze and fine clear weather. Course N54°E. Distance 264 miles
	3 P.M.	...	...	30·020	80·3	SE	3 to 4	Moderate breeze and fine clear weather.
	7 P.M.	...	...	30·036	77·3	SE	2 to 3	Slight breeze and fine weather.
	9 P.M.	...	...	...	...	SSE	...	Ship rolling to SW swell.
	11 P.M.	...	...	30·023	75·3	SSE	2 to 3	Squally with rain.
	Midnight	...	...	...	...	...	...	Light unsteady breeze and cloudy weather with rain at times, c. g. p.
S. S. Punjab	4 P.M.	At Karachi		29·775	81·6	SW	4	Moderate breeze and fine weather.
	8 P.M.	Karachi to Bombay		29·775	79·6	WSW	4	Moderate breeze and fine weather. Course S ¾ E; speed 9·3 knots.
	Midnight	...	...	29·755	76·6	WSW	4	Moderate breeze and fine weather.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"	°			
S. Queen's Cliff	Noon	4° 14′ N	58° 3′ E	...	...	SW	...	Strong breeze and squally. Ship rolling and labouring heavily. Course N 40° E. Distance 154 miles.
	Midnight	...	...	...	...	...	...	Strong breeze with heavy squalls and showers.
S. S. Rohilla	4 A.M.	...	...	29·709	86·0	S	...	Moderate breeze and overcast sky.
	8 A.M.	...	...	29·730	85·5	SSW	...	Fresh breeze and overcast sky. Ship rolling to southerly sea.
	Noon	15° 34′ N	58° 51′ E	29·731	89·0	SW	...	Light monsoon. Moderate sea. Ship rolling to SW swell. Course N 74° E. Distance 300 miles.
	4 P.M.	...	...	29·699	86·0	SW	...	Light breeze and fine weather.
	8 P.M.	...	...	29·706	85·0	SW	...	Moderate monsoon and fine weather.
	Midnight	...	...	29·709	86·0	W by S	...	Moderate monsoon and fine weather with passing clouds. Almost continuous sheet lightning.
S. S. Sestos	4 A.M.	...	...	...	...	ESE	...	Wind light and steady.
	8 A.M.	...	...	...	...	E	...	Moderate breeze.
	Noon	18° 33′ N	67° 51′ E	29·714	80·7	E	...	Moderate breeze with passing showers. Course 72° W. Distance 175 miles.
	4 P.M.	...	...	...	...	E	...	Moderate breeze and showery weather.
	8 P.M.	...	...	...	...	E by N	...	Moderate breeze and cloudy weather.
	9 P.M.	...	...	...	...	ENE	...	High cross swell. Lightning to W.
S. S. Sirdhana	1 A.M.	Bombay to Karachi		...	...	W	...	Moderate breeze and strong south-westerly swell. Ship rolling heavily.
	4 A.M.	...	...	29·786	81·7	...	...	Ditto ditto.
	8 A.M.	...	...	29·803	82·7	...	...	Light breeze and strong south-westerly swell.
	Noon	22° 46′ N	68° 1′ E	29·795	85·7	...	...	Ditto ditto; course N 46° W. Distance 204 miles.
	1 P.M.	...	...	...	...	SW	...	Light airs; heavy south-westerly swell; ship rolling heavily.
	4 P.M.	...	...	29·745	85·7	...	...	Ditto ditto.
	8 P.M.	...	...	29·761	83·7	...	...	Ditto ditto.
	Midnight.	...	...	29·753	82·7	...	...	Ditto ditto.
S. Slieve More	4 A.M.	...	...	...	...	SW	...	Fresh breeze and cloudy weather with continual lightning.
	Noon	8° 53′ N	64° 51′ E	29·820	...	SW	...	Heavy squall; course N 19° E. Distance 237 miles.
	4 P.M.	...	...	...	...	...	...	Strong wind and heavy squalls with misty weather.
	6 P.M.	...	...	...	...	...	...	Sunsets on 26th, 27th and 28th most gorgeous and variegated.
	8 P.M.	...	...	...	...	SW	...	Heavy squalls with continual lightning in N-W.
	Midnight.	...	...	...	...	...	...	Squally weather. Heavy sea.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Tebe . .	Noon	13° 44′ N	49° 24′ E	...	...	SW	2	
	8 P.M.	...	...	29·689	...	SW	2	
S. S. Tenasserim .	8 A.M.	...	...	29·776	83·7	Variable	1	Very heavy westerly swell; vessel rolling heavily.
	Noon	15° 31′ N	72° 35′ E	29·790	86·2	S	1	
	1 P.M.	...	...	...	...	S	2 to 3	Heavy southerly swell.
	4 P.M.	...	...	29·706	82·7	S	3	
	8 P.M.	...	...	29·780	90·7	S	3 to 4	Heavy swell from southward; vessel rolling heavily.
	Midnight.	...	...	29·778	90·7	SW	2 to 3	Vessel rolling heavily.
S.S. Wheatfield . .	1 A.M.	...	...	...	...	NE	...	Light breeze and overcast sky.
	8 A.M.	...	...	...	...	E	...	Light breeze and fine weather.
	Noon	15° 7′ N	54° 29′ E	...	...	SW	...	
	4 P.M.	...	...	...	...	...	...	Light breeze and cloudy sky with heavy SW swell.
	Midnight.	...	...	...	...	...	...	Light breeze and fine weather. Heavy southwest swell; ship rolling heavily.
S. S. Wistow Hall	Noon.	12° 26′ N	44° 9′ E	29·781	84·2	W	...	Fresh breeze and clear weather.
	7 P.M.	...	...	...	...	SE	...	Slight breeze and cloudy weather.
	Midnight.	...	...	...	...	...	...	Light breeze and clear weather.

The chart for the day, Plate XXIX, represents the meteorological conditions at noon. It shows that the cyclonic depression of the barometer had deepened very much during the preceding twenty-four hours, and that the centre had moved to the northward to about Lat. 15° 9′N, Long. 67° 28′E. At the same time the winds around it had become very much stronger than on the previous day, and were now blowing with great violence. The lowest pressure marked on the chart is 29·3″ at a distance of about 25 miles from the centre. Four and a half hours before noon, however, the *Berengaria*, which was then nearer to the centre than at noon, recorded a pressure of 29·15″, which is 0·68″ below the normal pressure for the time of the year. Later in the day, at 10 P.M., the *Africa*, when not very far from the centre, probably about 12 miles off, recorded a pressure of 28·8,″ which is the lowest in the records for the day, and about 1·03 inch below the normal pressure. The circular isobar of 29·7 had widened in diameter in the course of the twenty-four hours from about 380 miles to about 440 miles, and the diameter of the isobar of 29·5 had increased from about 90 miles to about 150 miles. Along the west coast of India from Bombay to Calicut, the pressure had fallen slightly, but farther to the north and south, it had risen somewhat. Still it was slightly above the normal at every coast station except Bombay, where a trifling depression had appeared. In the Arabian Sea to the south of the parallel of 10°N it had also risen, the isobar of 29·9 having moved one or two degrees northward, and that of 30·0 having made its appearance in the extreme south, for

the first time since the formation of the cyclonic vortex. At Aden, however, the pressure had fallen about four hundredths of an inch, and was now about nine hundredths below the normal.

At noon, the *Berengaria*, which was then about 25 miles to the south of the centre, recorded a fierce gale from W, gradually backing to southward as the cyclone moved towards the north-west. An hour later, the wind was from SW, blowing as hard as ever, but by midnight it had begun to moderate. Heavy rain was recorded at 10 A.M., and a heavy increasing sea throughout the day. The *Africa*, which at noon was about 50 miles to the west-north-west of the centre, was obliged to "heave to" on account of the violence of the wind, which was then blowing from the NNW. At 4 P.M. the wind had increased to a heavy gale, and at 6 P.M. it was still increasing with tremendous squalls, a confused sea, and a rapidly falling barometer. At 7 P.M. the wind was from NW; afterwards it backed to W and SW, and at 10 P.M., when the barometer was lowest, it was from SW. At midnight, when the barometer had begun to rise, the wind was "blowing a tremendous hurricane," the sea was mountainous, running from all directions of the compass, and there was continual lightning all round with loud peals of thunder and "blinding rain." The *Deva Gangadur*, which was about 120 miles to the south-west of the centre at noon, reported that at 5 A.M. the gale was moderating, but at 2 P.M. it was still recorded as a moderate gale from W with heavy squalls of wind and rain. At 8 P.M., a heavy sea from northward is recorded without any change of wind direction. Here again it is noteworthy that the direction of the sea was several points to the right of that of the wind. The *Mercedes*, which at noon was about 140 miles to the northward of the centre, reported a strong gale from E with a heavy confused sea from SE, again from a direction several points to the right of the wind. The wind increased in strength as the day advanced, and slowly backed to ENE. This shows that the vessel was passing through the northern half of the storm field, going from east to west, and steaming westward at a greater speed than that at which the storm was travelling. In fact the vessel was gradually overtaking the storm, and as the storm field was at the time moving north-westward, the ship was crossing the storm path, and so getting nearer and nearer to the centre. At 8 P.M. she experienced violent squalls of wind and rain. The *Sestos*, also homeward bound, had a very similar experience. At 4 A.M. she had a light wind from ESE. At noon the wind had increased to a moderate breeze, and had backed to E with cloudy showery weather. At 9 P.M. it had backed to ENE. At noon this vessel was about 230 miles to the northward of the centre, much farther away than the *Mercedes*. The winds were therefore relatively feeble. The *Clan Alpine* also passed through the northern half of the storm field, but as she was outward bound, going from west to east, the shift of the wind was observed in the opposite direction, *viz.*, from NW at 1 A.M. round by N at 8 A.M., to ENE at 4 P.M., the wind gradually increasing in strength from a moderate breeze to a fresh gale with hard squalls and heavy rain. At 8 A.M., when the wind was from N, a high southerly sea was recorded and a threatening appearance to the south-eastward in the direction of the storm centre. The weather was cloudy throughout the day, and heavy rain fell at intervals. The *Mistley Hall*, which at noon was about 230 miles to the west-south-west of the centre, reported a strong freshening breeze and an overcast sky from 1 A.M. to noon, the wind in the early part of the day being from WSW, but veering later to W and WNW under the influence of the cyclone, and increasing to a fresh gale from WNW in the

afternoon with "torrents of rain" and "terrific squalls," the barometer falling gradually from 29·73 at 1 A.M. to 29·57 at midnight. The *Inchulva*, which at noon was about 270 miles to the WNW of the centre, and directly in front of it, reported light north-westerly winds for the greater part of the day, and very heavy rain, with distinct but distant thunder at midnight.

There is ample evidence to show that outside the storm field to the south-west, between the storm and the equator, the south-westerly winds had again increased in strength, the average force from the observations of eight vessels having now risen to 5·2 on Beaufort's scale, in accordance with the increase of the barometric gradients resulting from the fall of pressure in the storm area and the rise in the extreme south. There is also consistent evidence from four vessels to the northward of Socotra to show that the south-westerly winds had advanced much farther northward than on the 27th, the winds in this region having now become south-westerly, whereas on the previous day they had been north-westerly. Between the storm field and the Bombay coast, the winds were light and southerly as on the previous day.

The storm had now begun to make itself felt on the west coast of India; the winds from Bombay to Calicut having become south-south-westerly, and the sea on the same portion of the coast having become very rough. These were the first signs on land of the existence of rough weather out at sea, but there were no indications which pointed decidedly to the actual formation of the cyclone.

On the same part of the west coast of India the weather was cloudy, but little or no rain had fallen; the greatest amount having been a local fall of four-tenths of an inch at Karwar. Farther to the north and south, the weather was comparatively clear. There was, as shown by the chart, a remarkable concentration of rainfall over the storm field, the weather conditions presenting, in this respect, a marked contrast with those of the previous day, rain having virtually ceased on the west coast, to the north of Socotra, and to the southward of the storm area. Heavy rain was reported, however, by two ships between latitudes 4° and 5°S, and passing showers by one near the equator.

1881, May 29.—The following tables contain the meteorological data for the 29th:—

TABLE XIX.—*10 A.M., 29th May 1881.*

Stations.	Barometer.	Change in twenty-four hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity Mean of day.					
					Miles per hour.		Per cent	0 to 10		
	"	"	"			°			"	
Zanzibar . .	30·104	+·038	+·028	SW	5	79·0	79	3	...	
Aden . . .	29·740	+·004	—·083	NNE	7	91·2	72	...	...	
Bushire . .	·743	+·005	+·051	NW	18	86·8	58	...	...	
Karachi . .	·73	+·010	+·052	SW	13	90·0	63	0	...	
Bhuj . . .	·739	—·007	+·051	SSW	9	95·4	44	0	...	
Rajkot . . .	·750	—·009	+·033	S	10	95·1	44	2	...	
Surat . . .	·790	—·009	+·021	W	14	93·5	49	0	...	

Station.	Barometer.	Change in twenty-four hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity Mean of day.					
	"	"	"		Miles per hour.	°	Per cent.	0 to 10	"	
Bombay . .	·800	+·004	—·007	S	25	87·4	68	7	...	Sea rough.
Ratnagiri . .	·827	+·008	+·025	S	...	90·1	59	0	...	
Karwar . .	·855	+·002	+·013	SW	...	84·1	76	5	0·39	
Mangalore . .	·891	+·016	+·038	S	4	84·9	74	6	0·46	Sea rough.
Calicut . . .	?	?	?	WNW	4	80·7	81	6	0·12	
Cochin . . .	·914	+·016	+·024	NNW	1	82·5	85	7	0·10	
Colombo . .	·895	. ?	+·007	SW	9	87·0	71	3	...	
Galle . . .	·893	+·005	+·015	NW	11	84·0	91	6	...	

TABLE XX—*29th May 1881.*

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. Africa . .	3 A.M.	...	...	29·259	...	...	...	Storm gradually decreasing in strength. Less lightning, thunder and rain.
	6 A.M.	...	...	29·359	...	...	...	
	Noon	...	...	...	...	...	...	Mountainous sea from SW.
	4 P.M.	...	...	29·509	...	...	...	Weather more moderate.
S. Berengaria .	6 A.M.	...	...	...	...	...	...	Barometer rising fast.
	Noon	16° 36′ N	69° 47′ E	29·650	...	SE	...	Moderate weather. Course N 51° E. Distance 152 miles.
S. S. Bessie Morris	1 A.M.	...	...	29·826	80·5	SW by S	6	Strong breeze and cloudy weather with heavy SW swell.
	6 A.M.	...	...	...	...	WSW	6	
	Noon	15° 10′ N	60° 48′ E	29·862?	85·5	WSW	6	Sky overcast Course N 79° E. Distance 247 miles.
	1 P.M.	...	...	29·718	...	WSW	7	Brisk gale and heavy squall with rain and high sea.
	5 P.M.	...	...	...	...	WSW	8	Increasing gale with very heavy squall and rain.
	6 P.M.	...	...	29·669	...	WSW	8	
	Midnight.	...	...	29·519	...	WSW	9	Heavy gale with high sea; squalls and rain.
S. Braidwood .	4 A.M.	...	...	...	...	SW	...	
	Noon	6° 59′ N	58° 43′ E	...	...	...	...	Course N 36° E.
	2 P.M.	...	...	...	...	SW	...	Moderate breeze and cloudy weather with showers of rain.
	Midnight.	...	...	...	...	...	...	Fine clear weather.
S. British Crown .	8 A.M.	...	...	...	...	W	...	Moderate breeze.
	10 A.M.	...	...	...	...	W by N	...	
	Noon	11° 47′ N	84° 8′ E	...	...	...	...	

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. British Crown —continued.	2 P.M.	...	...	...	...	W	...	Fresh breeze and cloudy weather.
S. S. Burmah	4 A.M.	Bombay to Karachi		...	84·6	Calm	...	High swell. Ship rolling heavily.
	8 A.M.	...	...	...	86·6	Variable	...	
	Noon	At Cutch Mandvi		...	87·6	Variable	...	Light breeze and fine weather.
	4 P.M.	...	...	...	86·6	SW	...	
	8 P.M.	...	...	...	87·6	...	...	Moderate breeze with heavy SW swell.
	Midnight.	...	...	...	85·6	...	...	Light breeze and cloudy weather.
S. Choice	8 A.M.	...	...	...	...	SW	...	Strong breeze and showery weather.
	Noon	6° 37′ N	58° 6′ E	30·065	...	...	...	Course N 33° E.
	1 P.M.	...	...	...	...	SW	...	Strong breeze and showery weather.
	8 P.M.	...	...	...	...	SW	...	Strong breeze and heavy squalls.
S. S. Clan Alpine	1 A.M.	...	...	...	...	ENE	...	Heavy gale with furious squalls.
	4 A.M.	...	...	29·362	...	E to ESE	...	Hard gale with furious squalls and high southerly sea.
	5 A.M.	...	...	...	...	E	...	Ditto ditto.
	8 A.M.	...	...	29·412	...	ESE	...	Ditto ditto.
	Noon	18° 18′ N	67° 48′ E	29·492	84·0	SE	...	Heavy gale and high cross sea. Course N 76° E. Distance 172 miles.
	4 P.M.	...	...	...	...	...	...	Gale decreasing. Cloudy weather and a heavy sea.
	7-30 P.M.	...	...	...	...	...	...	Less wind and clear weather.
	8 P.M.	...	...	...	...	...	...	Strong breeze and a clear sky.
	Midnight.	...	...	29·692	...	...	...	Ditto ditto.
S. S. Clandon	1 A.M.	...	...	...	...	W	...	Strong breeze and cloudy weather.
	Noon	14° 7′ N	55° 13′ E	...	...	W	...	Strong wind and sea. Course E by N ½ N.
	1 P.M.	...	...	...	...	W	...	Strong wind and heavy sea. Ship rolling heavily.
S. Deva Gangadur	8 A.M.	...	...	...	...	...	...	Ship rolling very heavily.
	Noon	13° 28′ N	67° 2′ E	29·595	...	...	...	Gale moderating. Course S. Distance 36 miles.
	2 P.M.	...	...	...	...	SW	...	
	Midnight.	...	...	...	...	...	...	Squally with heavy showers of rain.
S. S. Eschol	6 A.M.	...	...	...	...	SW	...	Moderate breeze with a heavy swell from SW.
	Noon	14° 42′ N	54° 31′ E	29·602	...	...	...	Fresh breeze and very warm weather. Course E by N. Distance 202 miles.
	2 P.M.	...	...	...	...	SW	...	Fresh breeze with a swell from the SW.
	Midnight.	...	...	...	...	...	...	Strong wind with heavy swell.
S. S. Euphrates	4 A.M.	...	...	29·785	81·1	SE	...	Moderate breeze and hazy weather. Heavy SW swell.
	8 A.M.	...	...	29·815	83·1	...	...	At 9-30 A.M., moderate breeze and high sea.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"	°			
S. S. Euphrates —continued.	Noon	21° 15′ N	69° 49′ E	29·845	85·1	SE	...	Fresh breeze and clear with a heavy SW swell. Course SE by E. Distance 31 miles.
	4 P.M.	...	...	29·785	85·1	S	...	Fresh breeze with a heavy SW sea. Ship rolling heavily.
	8 P.M.	...	...	29·845	83·1	S	...	Ditto ditto.
	Midnight.	...	...	29·845	79·1	S	...	Ditto ditto.
S. Exporter . .	Noon	9° 33′ N	63° 11′ E	...	...	SW	...	Squally weather. Course NE by N.
S. Hindustan .	4 A.M.	...	...	...	...	...	...	Strong breeze and clear weather.
	8 A.M.	...	...	...	...	SW	...	Strong monsoon.
	Noon	7° 25′ N	60° 34′ E	...	...	SW	...	Strong monsoon. Course N 40° E. Distance 196 miles.
	4 P.M.	...	...	...	...	...	...	Squally appearance in the westward.
	10 P.M.	...	...	...	...	SW	...	Strong squalls with rain.
	Midnight.	...	...	...	...	...	...	Strong breeze and fair weather.
S. S. Inchulva .	1 A.M.	...	...	...	...	N	...	Light wind coming in hot gusts, probably from the heated land to the northward. Cloudy weather. Thunder and lightning at intervals.
	4 A.M to 6 A.M.	...	...	...	...	...	...	Very heavy blinding rain.
	6 A.M.	...	...	...	...	...	...	Weather looking dirty. Sun rising red and fiery.
	8 A.M.	...	...	...	...	N	...	Strong gale. Ship hauled up to the N and engines going half speed.
	9 A.M.	...	...	...	...	...	...	First indication of an advancing cyclone.
	10 A.M.	...	...	...	...	NE	...	Wind blowing hard. Barometer falling fast.
	11 A.M.	...	...	...	...	NE	...	Cyclone blowing with terrific violence, carrying every thing before it. Wind increasing.
	Noon	...	...	...	...	NE	...	Terrific wind, steady at NE, blowing to atoms every thing it can reach.
	2 P.M.	...	...	27·15	...	Calm	...	In the centre of the cyclone. Calm with a fearful boiling sea. Heavy hanging clouds to SW.
	2-40 P.M.	...	...	...	...	SW	...	Light wind from SW increasing in a few minutes to greater violence than that of the wind from NE. Rain falling in torrents The howling of the wind destroys every other sound. Barometer rising; rose to 28 inches in less than one hour.
	3-20 P.M.	...	...	...	...	SW	...	Wind blowing the hardest, with torrents of rain through which it is impossible to see more than ten feet.
	4 P.M.	...	...	...	...	SW	...	Wind a little less violent.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Inchulva —continued.	5 P.M.	...	...	28·20	...	SSW	...	
	6 P.M.	...	...	28·60	...	...	...	
	8 P.M.	...	...	28·80	...	...	...	Very heavy rain and terrific gusts of wind.
	10 P.M.	...	...	...	...	S	...	Wind blowing very hard.
	11 P.M.	...	...	29·10	...	S	...	Wind blowing very hard with very heavy squalls and rain. Weather improved. A tremendous sea from all directions.
S. Iris.	1 A.M.	...	...	...	...	W by S	...	Fresh breeze and cloudy weather; squalls and rain; heavy squall at 1-30 A.M.; 8 A.M., strong breeze and squalls.
	Noon	10° 0′ N	64° 8′ E	29·757	...	...	...	Fresh breeze and cloudy weather. Course N 12° E. Distance 205 miles.
	1 P.M.	...	...	...	...	WSW	...	Strong winds with heavy squalls and rain.
	2 P.M.	...	...	...	...	...	...	Wind more moderate.
	Midnight.	...	...	...	...	...	...	Strong wind and squally.
S. S. Mercedes	1 A.M.	...	...	...	...	ENE	8	Strong gale with a heavy confused sea.
	6 A.M.	...	...	...	...	NE	9	Same weather and sea with heavy squalls of wind and rain. Unable to see more than a few yards ahead of the ship at times.
	Noon	17° 40′N	64° 11′ E	29·474	89·1	NNE	9	Furious gale with a fearful heavy confused sea. Course W. Distance 200 miles.
	1 P.M.	...	...	...	...	NNE	10	
	2 P.M.	...	...	...	...	NNE	10	
	3 P.M.	...	...	...	...	N by E	10	
	4 P.M.	...	...	...	...	N	10	A heavy squall and a sea struck the ship on the starboard border, heaving her on her port beam ends, and washing about 15 tons of coal off the deck. Ship righted a little, but still has a strong list to port. Every appearance of having been close to the centre of a cyclone travelling towards the NW.
	5 P.M.	...	...	...	...	N	11	
	6 P.M.	...	...	29·282	...	N	12	Wind blowing with terrific force and ship labouring greatly, and shipping vast quantities of water, washing every thing moveable overboard.
	7 P.M.	...	...	...	...	N	12	
	8 P.M.	...	...	29·268	...	N by W	12	Wind and sea terrific. Heavy squalls of rain. Sea confused and ship completely under water fore and aft.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Mercedes—contd.	9 P.M.	...	...	...	...	N.by W ½ W	12	
	10 P.M.	...	...	29·323	...	NNW	12	Wind and sea as before. Vessel labouring very heavily.
	11 P.M.	...	...	...	...	NNW	12	
	Midnight.	...	...	29·362	...	NW by N	12	Furious hurricane with terrific sea. Ship seems to be in a perilous condition.
S. Mistley Hall	1 A.M.	...	...	29·550	...	WNW	...	Freshening gale with terrific squall.
	5 A.M.	...	...	29·510	...	NW		
	9 A.M.	...	...	29·410	...	...	...	Terrific gale with fearful sea.
	Noon	15° 15′ N	66° 22′ E	29·310	...	WSW	...	Terrific gale with fearful sea. Course N 45° E. Distance 190 miles.
	6 P.M.	...	...	...	...	SW	...	Gale moderating but sea high and confused.
S. S. Nyanza	1 A.M.	...	...	30·045	74·3	SE by S	...	Light breeze and cloudy weather.
	7 A.M.	...	...	30·037	77·3	SE	4	Cloudy weather.
	11 A.M.	...	...	30·024	82·3	SE	4	
	Noon	2° 47′ N	50° 22′ E	...	...	SE	4	Moderate breeze and fine clear weather. Course N 54° E. Distance 266 miles.
	3 P.M.	...	...	30·020	80·7	SE	4	Moderate breeze and fine clear weather.
	5 P.M.	...	...	..	...	S	3 to 4	Ship rolling heavily.
	7 P.M.	...	...	30·018	77·3	S	3 to 4	Moderate breeze and cloudy weather.
	11 P.M.	...	...	30·023	75·3	S	3 to 4	Ditto ditto.
S. S. Punjab	4 A.M.	Karachi to Bombay		29·765	75·6	W	2	Light breeze and fine weather.
	8 A.M.	...	...	29·755	79·6	Calm	0	Calm and fine. Southwesterly swell.
	Noon	22° 19′ N	68° 26′ E	29·795	81·6	E	2	Course S 31° E. Distance 168 miles.
	4 P.M.	...	...	29·775	82·6	S	5	Fresh breeze and fine weather, heavy southerly sea. Ship plunging heavily.
	8 P.M.	...	...	29·775	79·6	S	5	Ditto ditto.
	Midnight.	...	...	29·755	74·6	S	4	Moderate breeze and fine weather. Ship pitching to heavy swell.
S. Queen's Cliff	Noon	8° 24′ N	59° 54′ E	...	...	SW	...	Strong breeze and clear weather. Course N 48° E. Distance 172 miles.
	2 P.M.	...	...	...	...	SW	...	Fresh gale. Ship rolling and labouring heavily, and shipping large quantities of water.
	Midnight.	...	...	...	...	...	...	Heavy squalls and showers.
S. S. Rohilla	4 A.M.	...	...	29·654	88·0	W by N	...	Moderate breeze and overcast sky. Sea from WSW.
	7 A.M.	...	...	...	...	WNW	...	Rather sharp squalls.
	8 A.M.	...	...	29·590	86·0	W by N	6	Strong monsoon; overcast sky; rain; high sea.
	10 A.M.	...	...	...	...	WNW		

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"	°			
S. S. Rohilla—contd.	Noon	16° 46′ N	63° 53′ E	29·515	84·0	WNW	9	Strong gale with heavy squalls of wind and rain. High confused sea from northward. Course N 76° E. Distance 300 miles.
	1 P.M.	...	...	29·465	...	NW	9	Threatening appearance. Concluded that a cyclone was passing ahead and to northward.
	2 P.M.	...	...	29·415	...	NW	10	High confused sea.
	3 P.M.	...	...	29·215	...	W	11	
	3-30 P.M.	...	...	29 195	...	W	11	Wind backed to west. Stood to the ESE to increase distance from the centre of the cyclone.
	4 P.M.	...	...	29 215	...	W by S	11	Terrific gusts of wind and very high confused sea. Ship lurching very heavily and taking much water over fore and aft.
	5 P.M.	...	...	29·235	...	WSW	12	
	6 P.M.	...	...	29·315	...	SW	11	Terrific gusts of wind with a very high confused sea. Ship labouring very heavily and taking water over fore and aft.
	7 P.M.	...	...	29·365	...	SW	11	
	8 P.M.	...	...	29·436	80·0	SW	10	Heavy gale with very heavy sea. Ship labouring and rolling very heavily.
	9 P.M.	...	...	29·446	...	SW	9	Sea and wind moderating a little; violent squalls of wind and rain at intervals.
	10 P.M.	...	...	29·566	...	SW	8	Kept ship away on course. Lightning to SE.
	11 P.M.	...	...	29·586	...	SW		
	Midnight.	...	...	29 606	...	SW	...	Gale of wind and heavy rain.
S. S. Rosetta	4 A.M.	...	...	29·823	82·1	W	...	Moderate breeze and fine weather with passing clouds.
	8 A.M.	...	...	29·876	81·1	...	...	Ditto ditto ditto.
	Noon.	7° 27′ N	77° 58′ E	29·853	82·1	W by S	...	Fresh breeze and fine weather.
	4 P.M.	...	...	29·765	85·1	...	...	
	8 P.M.	...	...	29·836	81·1	...	...	Light wind and fine weather.
	Midnight.	...	...	29·870	83·1	...	...	Ditto ditto ditto.
S. S. Sestos	1 A.M.	...	...	...	...	ENE	...	
	4 A.M.	...	...	...	...	ENE	...	Fresh breeze and overcast sky. Lightning to W and SW.
	8 A.M.	...	...	...	...	ENE		Breeze freshening; squally; cloudy to westward.
	Noon	18° 5′ N	64° 16′ E	29·547	78·7	ENE	...	Moderate gale; overcast and squally. Barometer falling. Course S 81° W. Distance 206 miles.
	4 P.M.	...	...	29·488	...	ENE	...	Moderate gale. Wind and sea increasing. Barometer falling.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Sestos —contd.	6 P.M.	...	...	...	...	ENE	...	Heavy squalls of wind and rain. Sea breaking right over the ship fore and aft.
	8 P.M.	...	...	...	...	ENE	...	Kept away to WSW. Ship unable to go her course through the terrible sea. Fresh gale with heavy squalls.
	Midnight.	...	...	...	...	ENE	...	Strong gale with violent hail squalls.
S. Slieve More	1 A.M.	...	...	...	...	SW		
	4 A.M.	...	...	...	...	...	...	Fresh breeze and squally weather.
	8 A.M.	...	...	...	...	...	...	Fresh gale with heavy sea. Shipping great quantities of water.
	Noon	11° 50′ N	66° 20′ E	29·720	...	SW	...	Confused sea from NW and WSW. Course N 27° E. Distance 208 miles.
	4 P.M.	...	...	...	...	...	...	Moderate breeze and cloudy weather. Heavy cross sea. Ship rolling heavily, filling decks with heavy seas.
	8 A.M.	...	...	...	...	...	...	Wind increasing with squalls.
	Midnight.	...	...	...	...	...	...	Moderate breeze and squally.
S. S. Tebe	4 A.M.	...	...	29·589	...	SW	4	
	Noon	14° 39′ N	53° 16′ E	...	...	SW	3	
	4 P.M.	...	...	29·599	...	SW	2	
	8 P.M.	...	...	29·604	...	SW	4	
	Midnight.	...	...	...	...	SW	4	
S. S. Wheatfield	1 A.M.	...	...	...	...	SW	...	Light breeze and fine weather. Ship rolling heavily to a SW swell.
	7 A.M.	...	...	...	...	WSW		
	Noon	16° 4′ N	57° 54′ E	29·582	...	...	...	Moderate breeze and threatening weather. Sky overcast with much thunder and lightning to E. Heavy increasing irregular sea. Course ENE.
	8 P.M.	...	...	...	...	...	...	Strong wind and cloudy weather with heavy sea.
S. S. Wistow Hall	1 A.M.	...	...	...	...	SE	...	Light airs. Hazy horizon.
	3 A.M.	...	...	...	...	SSE	...	Light breeze and clear sky.
	Noon	12° 48′ N	48° 35′ E	29·781	88·2	...	...	Light breeze and fine weather. Course N 85° E. Distance 266 miles.
	1 P.M.	...	...	...	...	E		
	3 P.M.	...	...	...	...	WSW	...	Moderate breeze and clear sky.
	5 P.M.	...	...	...	...	SW	...	8 P.M. Light airs and hazy.
	Midnight.	...	...	...	...	...	...	Light airs and cloudy weather.
S. S. Zambesi	4 A.M.	...	...	29·786	83·8	WNW	...	Moderate wind and sea. Fine weather.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°		'	
S. S. Zambezi —contd.	8 A.M.	...	...	29·800	85·8	...	...	Less wind and sea.
	Noon	8° 10' N	76° 51' E	...	...	NW	...	Course N 56° W. Light wind and fine weather. NW swell.
	4 P.M.	...	...	29·768	86·8	NW	...	Moderate breeze.
	8 P.M.	...	...	29·797	86·8			
	Midnight.	...	...	29·771	85·3	...	...	Light breeze and fine weather.

The chart for the day, Plate XXX, represents the barometer and wind observations at noon, and the general weather conditions of the whole day. It shows a very great intensification of the cyclonic depression during the preceding twenty-four hours, and a shifting of the centre towards the north-west to about Lat. 16° 40' N, and Long. 66° 14' E. The pressure in the centre had now gone down much below 28·0", and the diameter of the isobar of 29·5" had increased from about 150 miles to about 300 miles. Two hours after noon, the *Inchulva* was in the centre of the cyclone, where a pressure of 27·15" was recorded. This is 2·69 inches below the normal. This value was obtained from the indications of a large new aneroid barometer which was found to have no error when compared with a standard barometer in Bombay. In the centre of the cyclone the pointer of the aneroid went down to the reading 27·45", where it was stopped by the stem of an attached thermometer. The actual pressure having been lower than this, the fine steel pointer was bent like a spring, and it was estimated by the commander of the vessel that a tangent line drawn through the centre of the pointer along the inner straight portion and produced as far as the scale, would have cut the scale at 27·3". The vacuum box must therefore have been exerting a pressure on the pointer, equivalent to the difference between 27·3" and 27·45", *viz.*, to ·15 of an inch at least, and this quantity deducted from 27·3" gives the reading 27·15", which has been adopted as the reading in the centre of the cyclone. To the south-west of the storm field the pressure had risen considerably, the isobar of 30·0 having advanced northward about $2\frac{1}{2}°$, that of 29·9 about 2°, and that of 29·8 about 1°, while that of 29·7 remained nearly stationary. Along the west coast of India the pressure had changed very slightly, a very trifling rise having occurred to the southward of Bombay, and an equally small fall to the northward. At Aden also the pressure had changed very little. The changes of pressure in the storm field and to the south-west of it largely increased the barometric gradients, and accordingly, the force of the winds was very greatly strengthened. All the vessels within a distance of 160 miles from the centre of the cyclone, of which there were six, reported a force of 9 or more. The *Inchulva* which, at noon, was about 30 miles to the north-west of the centre, had a strong gale from N at 8 A.M. At 10 A.M., the wind veered to NE, where it remained steady until noon, blowing with terrific violence and carrying everything before it. At 2 P.M., it fell, somewhat suddenly, to a calm, which lasted about 40 minutes. Shortly before 3 P.M., the wind began to blow from SW, lightly at first, but increasing in a few minutes to greater violence than before, and remaining at SW until 5 P.M., when it backed to SSW, and at 10 P.M. to S. The veering of the wind from N to NE

through four points of the compass, with the approach of the centre, and the backing from SW to S, also through four points, as the centre receded from the vessel, are somewhat inconsistent with the supposition that the ship passed in a straight line through the whole of the storm field from NE to SW. During this time the vessel was "hove to," and the storm centre was travelling in a north-westerly direction at the rate of about 7·2 miles per hour. In the 14 hours from 8 A.M. to 10 P.M., it would therefore travel about 101 miles, and as the ship passed through the centre about the middle of the period of 14 hours, she would be about 50 miles on one side of the centre at the commencement of the period, and about the same distance on the other side at the end. Yet within these short distances the wind shifted four points on each side of the centre. It will be seen from what follows, that, even at a distance of 150 miles from the centre, the wind, in a fully developed cyclone, may be much more nearly tangential than radial, and that on the average, in the cyclone now under consideration, it turned inwards only about two points, that is to say, it made an angle with the radius of about six points. Near the centre, the wind was tangential, making an angle of eight points with the radius. A vessel passing straight through the centre of such a cyclone would therefore observe a veering of the wind through only two points between the outside and the centre, a sudden shift of sixteen points at the centre, and a backing of two points between the centre and the opposite side. The only way to explain the great amount of veering and backing observed on the *Inchulva*, when within 50 miles of the centre, seems to be, to suppose that the vessel entered the more violent central portion of the cyclone on the west side; that she made some little headway against the wind, which was there blowing from N; that this northward motion, combined with the north-west movement of the storm, brought the vessel to the north-west side of the centre, where the wind was NE; that the storm centre then passed over her, leaving her on the south-east side with the wind from SW; and that she was then carried round to the east side, where the wind was from S. The log of this vessel is so important that the whole of the information for the 29th May is transcribed below:—

SUNDAY, MAY 29TH, 1881.

"Begins with dull cloudy weather. Wind light but increasing from the north. Thunder and lightning at intervals. 4 to 6 A.M.—Very heavy blinding rain. 6 A.M.—Took in the fore and aft sail, weather looking dirty, and sun rising red and fiery. We haul up the north and go half speed. 9 A.M.—We have the first indication of a cyclone advancing. All hands are called. We make the ship as snug as possible, secure everything ready for violent weather. At 10 A M., it blows hard and shifts to the NE. Barometer falls fast. 11 A.M., the cyclone bursts over us, blowing with terrific violence. It carries everything before it. We consider ourselves in the NW quadrant with the centre coming up from SE so fast there is no time to dodge it. So we prepare for this dreaded centre to pass over us. The wind increases much as it advances. The sea cannot rise. We notice the most from the E and SE. Noon, a terrific wind still at NE, steady. Away goes fore gaff and fore trysail, hatches, in fact, everything the wind can reach blows to atoms. 2 P.M., the centre passes over us. During this time it is calm with a fearful boiling sea. The clouds hang heavy to the SW. Sun's limb clearly visible through thin yellowish haze; also several stars, at least a dozen. 2-40 P.M.—

wind light from SW; in a few minutes the cyclone has increased in force to a greater extent than that part of the storm at NE; rain falls in torrents. The howling of the wind, the drift, the howling noise destroy every other sound. Awnings, all snugly furled, blow to atoms; boat covers, ridge poles, stanchions, gangway, every thing is swept clean away. At 3·20 P.M. it blows the hardest from SW, and SSW; but veering to the S. The rain falls in torrents. The drift is so dense that we can see no more than 10 feet. We are not able to move. The hatches, all well secured, blow off; locking bars and tarpaulins go to pieces. At 4 P.M. the wind ceases a little. During the time the centre was passing over us, the barometer fell until the hand came against the tube of the thermometer, so could fall no more. We see many land birds and butterflies and whales in the centre. We employ ourselves during the calm interval clearing up the wreck and getting on hatches. As soon as the wind goes to SW, the barometer rises and continues so to do as the centre passes away from us. On the advancing half we laid in the port tack, engines going dead slow, or stopped. On the receding half we go in starboard tack, engines going the same. But the great violence of wind and a cross sea pay her head off to the port tack again, and in this position we are obliged to remain. 10 P.M.—wind S, blowing very hard. 11 P.M.—wind S, with *very heavy* squalls and *rain*. Though there is a decided improvement in the weather, barometer stands steady at 29·020, and during this time the squalls are most violent; the atmosphere loaded with flash lightning. Midnight—Barometer 29·109; weather improves; a tremendous sea from all directions rolls up. Crew engaged bailing out the stoke hole. Passengers were all put into No. 4 hold and their wants attended to."

The *Afrika* which at noon was about 90 miles to the south-west of the storm centre, reported a gradual rise of the barometer from 29·26″ at 3 A.M. to 29·51″ at 4 P.M. with a gradual decrease of the strength of the wind and less lightning, thunder, and rain At noon the sea was recorded as "mountainous from SW."

The *Mistley Hall*, about 100 miles to the south of the centre, reported a fall of the barometer from 29·55″ at 1 A.M. to 29·31″ at noon, with a freshening gale from WNW, and a terrific gale with fearful sea from 9 A.M. to noon, the wind backing gradually to WSW at noon, and to SW at 6 P.M., when it began to moderate, leaving the sea high and confused. The *Clan Alpine*, which at noon was about 150 miles to the north-east of the centre, after having passed through the northern half of the storm field, reported a gradual rise of the barometer from 29·36″ at 4 A.M. to 29·69″ at midnight, and a heavy gale veering gradually from ENE at 1 A.M. to SE at noon, with furious squalls and a high southerly sea. After noon the gale began to moderate and by 8 P.M. it had fallen to a strong breeze with fine clear weather. Here again the sea is reported to have come from several points to the right of the wind direction. The *Rohilla* which, at noon, was about 150 miles to the west of the centre, furnishes a very complete and instructive log. The barometer fell from 29·65″ at 4 A.M. to 29·19″ at 3·30 P.M., and rose to 29·61″ at midnight. At noon the wind blew with the force of a strong gale from WNW, with heavy squalls of wind and rain, and a high confused sea from the northward, which is again several points to the right of the wind. By 1 P.M. the wind had veered to NW and by 2 P.M. it had increased to force 10 of Beaufort's scale. At 3 P.M. it backed to W and increased to force 11. The course of the ship, which up to 3·30 P.M. had been N 76° E, was then changed to ESE, and the barometer immediately began to rise. The wind then

gradually backed until, at 6 P.M., it was from SW, where it remained for the rest of the day. The greatest force, 12, was observed at 5 P.M. when the direction was WSW, after which the force gradually fell to 8 at 10 P.M., when the proper course of the ship was resumed. From 4 P.M. to 6 P.M., terrific gusts of wind and a very high confused sea were recorded, and later in the day, violent squalls with heavy rain. The *Mercedes*, which was homeward bound, also furnishes very complete information for this day. At noon she was about 150 miles to the north-west of the centre in front of the advancing storm. Her barometer fell from 29·47″ at noon to 29·27″, the lowest recorded, at 8 P.M. The wind gradually backed from ENE, force 8, at 1 A.M., round by N force 11, at 5 P.M., to NW by N, force 12, at midnight. When the barometer was lowest at 8 P.M., the wind was from N by W, force 12. A confused sea with heavy squalls of wind and rain was reported at 6 A.M. The rain was so heavy that it was impossible, at times, to see more than a few yards ahead of the ship. From 6 P.M. to midnight the wind blew with hurricane force, raising a terrific sea which seriously damaged the vessel. The *Sestos* was also on the north-west side of the cyclone at noon on the 29th, about 170 miles from the centre. This vessel reports the wind to have been steady from ENE throughout the day, which appears to be somewhat doubtful. Probably the direction was observed very roughly, or some evidence of a change would have been noticed, as on the *Mercedes*. The force of the wind gradually rose from a fresh breeze at 4 A.M. to a strong gale at midnight, with violent hail and rain squalls, and a terrible sea, through which the vessel was unable to keep her course. This observation of hail is very important, as it affords information relating to the vertical thickness of the cyclone—a subject which will be discussed hereafter. The *Bessie Morris* was at noon about 370 miles to the west-south-west of the centre, steaming in a direct line towards it. She reported a fall of the barometer from 29·83″ at 1 A.M. to 29·52″ at midnight, and a gale from WSW the force of which gradually increased, from 6 at noon to 9 at midnight, with a high sea, rain, and very heavy squalls. At noon the *Deva Gangadur* was about 220 miles to the south-south-west of the centre, and still within the influence of the cyclone, although she reported that the gale and the squalls were moderating; even at midnight the weather was still squally with heavy showers of rain. Only one observation of the wind direction is recorded, *viz.*, SW at 2 P.M. Probably the wind remained steady at SW throughout the day. The *Berengaria* which at noon was about 240 miles to the east of the centre, reported a fast rising barometer and moderate weather with the wind from SE.

Outside the storm area, that is to say, outside the isobar of 29·7″, and to the south-west the winds were south-westerly, blowing with an average force of 5·6, as determined from the observations of nine vessels. This is ·4 greater than on the previous day, proving that the south-west monsoon wind was increasing in strength at the same time that the cyclone was increasing in violence. To the north and north-east of Socotra, the winds were also southwesterly with an average force of 4·8, as determined from the observations of five vessels. On the previous day the observations of four vessels in the same part of the sea, give an average force of 3·2, also from SW. Hence it may be inferred that on the 29th, the south-westerly winds had advanced over that part of the sea much farther northward than on the 28th.

On the west coast of India, the winds were southerly from Mangalore to Bombay, and stronger than on the 28th. On the coast of Kathiawar also the winds were beginning to be influenced by the cyclone. The *Punjab* off the mouth of the Gulf of Cutch, reported a

light wind at noon from E gradually veering to S and increasing to force 5 in the afternoon, as she travelled south-eastward; while the *Euphrates*, which was off the coast of Kathiawar, also going south-east, reported a fresh SE breeze veering to S in the after, noon. These two vessels were fully 400 miles from the centre of the cyclone, and yet the winds observed by them and at Bombay, about 450 miles away, were very decidedly influenced by it.

As on the 28th, the rainfall was for the most part concentrated in the storm field, though not exclusively confined to it, light rain having fallen along the west coast from Cochin to Karwar and over the sea about 700 miles to the south-west of the storm centre. The sea was rough, as on the previous day, from Mangalore to Bombay.

1881, May 30.—The information for this day is contained in the two following tables and in the chart for noon of the same date, Plate XXXI.

TABLE XXI.—*10 A.M. 30th May 1881.*

Station.	Barometer.	Change in 24 hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall	Remarks on the weather at 10 A.M.
				Direction.	Velocity, mean of day.					
	″	″	″		Miles per hour.	°	Per cent.	0 to 10	″	
Zanzibar . .	30·080	—·024	+·001	SW	5	77·7	83	4	...	
Aden . .	29·750	+·010	—·070	SW	8	88·2	81	...	...	
Bushire . .	·664	—·079	—·022	NW	17	84·8	54	...	...	
Karachi . .	·732	—·005	+·051	S	10	90·0	65	0	...	
Bhuj . . .	·719	—·020	+·035	S	13	92·2	43	0	0·00	
Rajkot . .	·738	—·012	+·024	S	13	91·2	48	9	0·10	
Surat . .	·785	—·005	+·019	S	15	91·5	51	5	...	
Bombay . .	·802	+·002	—·003	SSE	24	86·5	74	6	0·20	Sea rough.
Ratnagiri . .	·849	+·022	+·048	SSE	...	86·5	64	5	0·48	
Karwar . .	·869	+·014	+·028	SW	...	84·1	74	5	0·70	Fresh wind.
Mangalore .	·893	+·002	+·040	Calm	3	87·4	64	7	0·44	
Calicut . .	·912	?	+·031	WNW	6	81·7	82	3	0·11	Sea rough.
Cochin . .	·913	—·001	—·023	NNW	1	81·0	91	10	0·38	
Colombo . .	·886	—·009	—·002	SW	9	84·5	74	7	...	
Galle . .	·874	—·019	—·004	NW	9	83·0	91	2	0·02	

TABLE XXII.—*30th May 1831.*

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				″	°			
S. Africa . .	6 A.M.	...	...	29·639	...	...	...	
	Noon	15° 44′ N	67° 40′ E	...	...	...	...	
	Mid-night.	...	...	...	...	...	...	Strong breeze and cloudy weather.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S.S. Arabia .	Noon	At Jask	...	29·733	87·7	...	...	Light wind and fine weather.
	1 P.M.	Jask to Muscat		...	...	SSE	2	[illegible]
	4 P.M.	...	...	29·690	88·7	SSE	2	[illegible] weather. Ditto ditto.
	8 P.M.	...	...	29·773	87·7	SSE	2	Moderate wind with heavy swell.
	Midnight.	...	...	29·756	86·7	SE	2	Moderate wind with passing clouds and hazy horizon.
S. Berengaria .	Noon	17° 43′ N	72° 49′ E	29·650	...	SE	...	Fine weather. Moderate breeze. Course N 73° E. Distance 152 miles.
S.S. Bessie Morris	1 A.M.	...	...	29·524	81·5	WSW	10	Gale with terrific squalls of wind, much lightning and a perfect deluge of rain.
	7 A.M.	...	...	29·621	...	WSW	9	Heavy sea.
	10 A.M.	...	...	29·671	...	WSW	8	
	Noon	15° 50′ N	65° 16′ E	29·715	84·5	WSW	7	Wind moderating and sea going down. Course N 81° E. Distance 261 miles.
	1 P.M.	...	...	29·721	...	WSW	7	Gale moderating.
	5 P.M.	...	...	...	...	SW	6	
	9 P.M.	...	...	...	...	SW by S	6	
	Midnight.	...	...	29·771	...	SW by S	6	Strong breeze and fine weather.
S. Braidwood .	Noon	8° 58′ N	61° 17′ E	...	...	SW	...	Course N 42° E. Fine clear weather.
	Midnight.	...	...	...	...	SW	...	Cloudy with drizzling rain.
S. British Crown .	4 A.M.	...	...	...	...	WSW	...	Heavy sea. Decks constantly flooded with water.
	10 A.M.	...	...	...	...	SW	...	
	Noon	12° 53′ N	66° 22′ E	...	...	...	...	
	2 P.M.	...	...	...	...	SW	...	Squally strong breeze.
	8 P.M.	...	...	...	...	SWbyW	...	Moderate breeze. Sky partly clouded.
S. Choice . .	6 A.M.	...	...	...	...	SW	...	Heavy squall.
	Noon	8° 42′ N	60° 25′ E	29·965	...	SW	...	Course N 53° E.
	1 P.M.	...	...	...	...	SW	...	Strong breeze and squally.
	7 P.M. to Midnight.	...	...	...	...	SW	...	Strong steady breeze and fine weather.
S. S. Clan Alpine .	1 A.M.	...	...	29·792	85·2	SE	...	Moderate breeze and fine clear weather.
	4 A.M.	...	...	...	...	E	...	Wind falling light.
	6 A.M.	...	...	...	...	SE	...	Fresh breeze and clear weather.
	Noon	19° 6′ N	71° 23′ E	...	...	SSE	...	Fresh breeze and high sea.
	1 P.M.	...	...	29·747	...	...	...	
S. S. Clandon .	1 A.M.	...	...	...	...	W	...	Strong breeze and heavy sea.
	6 A.M.	...	...	...	...	...	...	Very cloudy; ship rolling heavily and straining much.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Clandon—contd.	Noon	15° 19′ N	58° 50′ E	...	...	...	...	
	4 P.M.	...	...	...	...	...	...	Increasing wind and passing showers.
	Midnight.	...	...	...	...	...	...	Strong gale.
S. Deva Gangadur	Noon	15° 14′ N	67° 2′ E	29·595	...	SW	...	Squally with showers of rain. Course N. Distance 106 miles.
	2 P.M.	...	...	...	...	...	...	Squally with showers of rain.
S. S. Eschol	Noon	15° 28′ N	58° 4′ E	29·502	...	SW	...	Heavy swell with light breeze; weather hot and sultry.
	2 P.M.	...	...	...	...	WSW	...	
	4 P.M.	...	...	29·202	...	...	...	Breeze freshening with a very heavy swell.
	8 P.M.	...	...	...	...	SW	...	
	Midnight.	...	...	...	...	...	...	Fresh gale with a high sea.
S. S. Euphrates	4 A.M.	...	...	29·785	83·1	S	...	Strong breeze with a heavy SW swell.
	8 A.M.	...	...	29·865	83·1	S	...	Moderate breeze with a heavy SW swell.
	Noon	19° 21′ N	72° 24′ E	29·845	81·1	S	...	Fresh breeze and clear weather with a heavy SW swell. Course S 50° E. Distance 145 miles.
	4 P.M.	...	...	29·815	81·1	S	...	Moderate breeze and clear weather with a heavy swell; ship rolling heavily.
	8 P.M.	...	...	29·865	80·1	S	...	
	Midnight.	...	...	...	...	S	...	Moderate breeze and cloudy weather.
S. Exporter	Noon	11° 59′ N	65° 39′ E	...	...	SW	...	Fresh wind and squally weather.
S. Hindustan	4 A.M.	...	...	...	...	...	...	Strong breeze and fair weather.
	8 A.M.	...	...	...	...	SW	...	Steady monsoon and fine weather.
	Noon	9° 41′ N	63° 0′ E	...	...	...	...	Strong breeze and clear weather. Course N 47° E. Distance 199 miles.
	1 P.M.	...	...	...	...	SW	...	Strong monsoon with high SW sea.
	8 P.M. to Midnight.	...	...	...	...	...	...	Very steady monsoon throughout.
S. S. Inchulva	1 A.M.	...	...	...	...	S	...	Weather moderating slowly.
	2 A.M.	...	...	...	...	S by E	...	Barometer rising.
	3 A.M.	...	...	...	...	...	...	Sea very heavy indeed.
	4 A.M.	...	...	...	...	S to S by E	...	Wind much less.
	5·30 A.M.	...	...	...	...	...	...	Kept ship away on course NE by E.
	10 A.M.	...	...	29·50	81·7	...	...	Barometer steady.
	1 P.M.	...	...	...	...	SSE	...	
	6 P.M.	...	...	...	...	SSW	...	Strong wind with heavy SW sea; engines going slowly.
	8 P.M.	...	...	...	...	...	...	Moderate weather; sky clearing up.
	11 P.M.	...	...	29·70	...	...	...	Ditto ditto.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. Iris	1 A.M.	...	...	...	...	SW by W	...	Strong breeze; heavy squall with rain at 3·30 A.M.
	6 A.M.	...	...	...	...	...	...	Several squalls.
	Noon	12° 55′ N	66° 9′ E	29·727	...	SW	...	Strong wind and heavy squalls; heavy sea. Course N 34° E. Distance 212 miles.
	Midnight.	...	...	...	...	SSW	...	Moderate breeze and clear weather with heavy swell.
S. S. John Pender	1 A.M.	...	...	29·42	82	NW by W	...	Strong gale with violent squalls of wind and rain; vivid lightning to north and west; heavy confused sea.
	4 A.M.	...	...	...	...	NW	...	Strong gale with heavy squalls of wind and rain; very high sea.
	8 A.M.	...	...	29·42	81	...	...	Gale increasing with tremendous sea and violent squalls.
	Noon	18° 3′ N	61° 46′ E	29·42	83	WNW	...	Hard gale with a very high sea.
	1 P.M.	...	...	...	...	W by S	...	Strong gale with violent squalls.
	4 P.M.	...	...	29·38	81	W	...	Gale increasing.
	6.30 P.M.	...	...	...	...	...	...	Very severe gale with terrific squalls of wind and rain, and tremendous sea.
	8 P.M.	...	...	29·30	82	...	...	Gale still increasing, weather very dirty; tremendous sea; barometer still going down.
	Midnight	...	...	29·20	81	...	...	Terrific gale and tremendous sea.
S. S. Mercedes	1 A.M.	...	...	...	...	NW	12	Hurricane of wind and a mountainous confused sea; ship has a strong list to port and is almost unmanageable.
	2 A.M.	...	...	29·382	...	NW	12	Sea very confused. Ship labouring heavily.
	4 A.M.	...	...	...	...	WNW	12	Wind less violent but heavy squalls of rain. Sea less confused.
	6 A.M.	...	...	...	...	W	12	Ship almost unmanageable.
	8 A.M.	...	...	29·402	...	WSW	12	Wind and sea as before; violent squalls of wind and rain.
	10 A.M.	...	...	...	...	SW	11	Wind more steady and sea less confused. Heavy mountainous sea, and ship with fearful list to port. Port rail continually under water.
	Noon	15° 50′ N	64° 3′ E	29·422	87·1	SW	11	Ship labouring fearfully. Seems in a perilous condition. Course S ¼ W. Distance 116 miles.
	4 P.M.	...	...	...	...	SW	10	
	8 P.M.	...	...	...	...	SW	10	Wind and sea less violent, running true.
	Midnight.	...	...	29·482	...	SW	10	Violent gale, wind and sea terrific.
S. Mistley Hall	1 A.M.	...	...	...	...	SW	...	Increasing gale with heavy sea. Ship labouring and rolling heavily and shipping large quantities of water.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"	°			
S. Mistley Hall—contd	6 A.M.	...	...	...	...	...	...	Gale moderating.
	Noon	14° 59′ N	66° 0′ E	...	...	...	...	Strong breeze with heavy squalls. Squared away to the northward and eastward.
S. S. Nyanza	3 A.M.	...	...	30·003	75·3	S	4 to 5	Moderate to fresh breeze with passing clouds.
	7 A.M.	...	...	29·595	78·3	S	4 to 5	Fresh breeze and cloudy weather.
	Noon	5° 11′ N	54° 13′ E	30·072	83·3	S	4 to 5	Fresh breeze with passing clouds. Ship rolling heavily. Course N 54½° E. Distance 268 miles.
	3 P.M.	...	...	29·980	80·3	S	4 to 5	
	4 P.M.	...	...	...	...	S	4 to 5	Wind unsteady and squally with small rain.
	6 P.M.	...	...	...	...	SE to SW	3 to 6	
	8 P.M.	...	...	29·988	77·3	S	4 to 5	
	Midnight.	...	...	30·003	75·3	...	...	Fresh breeze and cloudy weather. Ship rolling heavily to SW swell.
S. S. Punjab	4 A.M.	Karachi to Bombay		29·755	72·6	SE	6	Strong wind and fine weather. Heavy sea from SW.
	8 A.M.	...	...	29·775	77·6	SSE	6	Ditto ditto.
	Noon	20° 17′ N	70° 50′ E	29·775	77·6	SSW	6	Strong wind and fine weather. Heavy sea from SW. Course S 48° E. Distance 184 miles.
	4 P.M.	...	...	29·775	76·6	SW	6	Weather as at noon.
	8 P.M.	...	...	29·755	78·6	SW	6 to 7	Strong breeze and squally, with cloudy weather. High sea. Ship rolling heavily.
	Midnight.	...	...	29·775	74·6	SW	5	Fine breeze and heavy SW swell.
S. Queen's Cliff	Noon	...	...	...	...	SW	...	Fresh gale. Course N 45° E. Distance 208 miles.
	2 P.M.	...	...	...	...	SW	...	Fresh gale with passing squalls and showers.
S. S. Rohilla	4 A.M.	...	...	29·606	80·0	...	...	Moderating gale and less sea. Ship rolling heavily and taking large quantities of water over all fore and aft, at times.
	5 A.M.	...	...	...	...	...	...	Overcast with rain.
	8 A.M.	...	...	29·698	83·0	...	...	Moderate gale and heavy sea. Ship rolling heavily and taking water over fore and aft.
	Noon	17° 0′ N	68° 44′ E	29·702	85·0	...	...	Fresh breeze and overcast sky.
	4 P.M.	...	...	29·720	86·0	...	...	Moderate breeze and overcast sky.
	8 P.M.	...	...	29·725	84·0	SSE	...	Moderate breeze and fine weather with passing clouds.
	Midnight.	...	...	29·752	85·0	...	...	Ditto ditto.
S. S. Sestos	1 A.M.	...	...	...	...	NE	...	Heavy gale.
	2 A.M.	...	...	29·424	...	N	...	Terrific and increasing gale with terrific and blinding squalls of rain.
	3 A.M.	...	...	...	...	NW		

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Sestos—contd.	4 A.M.	...	...	29·394	...	W	...	Wind still backing to westward, kept the ship away and ran till 7-30 A.M., when straining so badly, brought her head to wind.
	5 A.M.	...	...	...	...	W		
	7 A.M.	...	...	...	...	SW		
	8 A.M.	...	...	29·444	...	SW	...	Heavy gale with violent squalls of hail and rain. A tremendous sea broke on board on the port side doing much damage.
	Noon	17° 14′ N	62° 50′ E	29·453	...	...	...	Very heavy gale with terrific squalls of wind and rain. Barometer falling in the squall from 29·45 to 29·39.
	6 P.M.	...	...	29·473	...	...	...	Barometer rising. Wind and weather the same.
	8 P.M.	...	...	...	...	...	...	Squalls still very violent but less wind between them
	10 P.M.	...	...	...	...	...	...	Gale breaking, squalls very heavy. Barometer steadily and slowly rising.
	Midnight.	...	...	29·494	...	SW	...	Strong gale, overcast, squalls less severe and frequent. Sea still running very high, and vessel straining and labouring heavily.
S. S. Sirdhana	4 A.M.	At Karachi		29·746	81·7	SW		
	8 A.M.	Karachi to Bombay		29·768	84·7	SW		
	Noon	24° 18′ N	66° 53′ E	29·773	86·7	SE	...	Light airs and very heavy SE sea. Ship pitching very heavily. Course S 6° W. Distance 40 miles.
	4 P.M.	...	...	29·745	85·7	SE	...	Moderate wind, heavy sea, ship labouring very violently.
	8 P.M.	...	...	29·738	84·7	SE	...	Ditto ditto.
	Midnight.	...	...	29·718	84·7	SE	...	Wind and sea increasing. Ship labouring more severely.
S. Slieve More	1 A.M.	...	...	...	...	SSW	...	
	8 A.M.	...	...	...	...	...	...	Moderate breeze and heavy sea.
	Noon	14° 29′ N	68° 13′ E	29·770	86	SSW	...	Fine weather but tremendously heavy sea from WSW. Course N32° E. Distance 186 miles.
	8 P.M.	...	...	...	...	SSW	...	Fresh breeze with heavy SW sea.
	11 P.M.	...	...	...	...	SW	...	
S. S. Tebe	4 A.M.	...	...	...	...	SW	4	
	8 A.M.	...	...	...	...	SW	4	
	Noon	15° 23′ N	57° 2′ E	...	...	SW	6	Strong wind and cross sea continuous for two days.
	4 P.M.	...	...	29·604	...	SW	6	
	8 P.M.	...	...	...	...	SW	6	
	Midnight.	...	...	...	...	SW	6	

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				″	°			
S. S. Wheatfield	1 A.M.	...	...	...	...	WSW	...	Strong breeze and cloudy weather with lightning to the eastward. Heavy SW swell.
	4 A.M.	...	...	...	...	...	...	Strong increasing wind with hard squalls.
	8 A.M.	...	...	29·382?	...	W	...	Strong wind with squalls of rain. Lightning.
	Noon	16° 59′ N	61° 48′ E.	...	...	...	...	
	10 P.M.	...	...	...	...	WSW	...	
	Mid-night.	...	...	29·232?	...	...	...	Whole gale with very heavy squalls and high sea. Ship labouring heavily and filling the decks with water.
S. S. Wiston Hall	1 A.M.	...	...	...	...	SE	...	Light breeze and hazy weather.
	4 A.M.	...	...	...	...	S	...	Moderate breeze with a south swell. Ship rolling heavily and shipping water.
	Noon	13° 47′ N	52° 55′ E	29·784	83·2	SW	...	Fresh breeze and hazy weather with increasing SW swell. Course N 77° E. Distance 258 miles.
	8 P.M.	...	...	...	...	...	...	Similar weather with a SW sea.
	Mid-night.	...	...	...	...	SSW	...	Fresh breeze and hazy horizon.

The chart, Plate XXXI, shows a still further development of the cyclone, and a rapid change of position, the diameter of the isobar of 29·5″ having increased, in the previous twenty-four hours, from about 300 miles to about 370 miles, and the centre having now moved about 210 miles to the north-westward to about lat. 18° 36′ N and long. 63° 45′ E. No ships are known to have been very near the centre on this day. Hence the pressure there is unknown, but, as the general dimensions of the cyclone had increased, it is probable the central depression was lower than on the 29th. The lowest recorded pressure at noon is 29·42″ on the *John Pender*, which was then about 130 miles from the centre. Twelve hours later, however, the same vessel reported a pressure of 29·20″, which is about ·63″ below normal, and the *Sestos*, which at noon was about 110 miles to the south-south-west of the centre, reported a pressure of 29·39″ at 4 A.M. In the south-west quarter of the Arabian sea the pressure had again risen considerably, the isobar of 30·1″ having now made its appearance there for the first time since the commencement of the storm. Along the 56th meridian, in the neighbourhood of which the rise was greatest, this isobar had extended northwnrd to about lat. 4° N, while that of 30·0″ measuring on the same meridian, had moved northward to about lat. 7½° N, and that of 29·9″ to about lat. 10½° N. At Aden also the pressure rose a little, but in Ceylon and along the west coast of India, to the north of Bombay, it fell slightly, while on the intermediate coast line it rose a little. The changes along the coast were, however, small and unimportant, compared with those which took place in the storm field and to the south-west of it. The winds within the storm circle appear to have been at least as violent as on the 28th, probably more so. The *Sestos* reported a heavy gale from NE at 1 A.M., and a "terrible and increasing gale"

from N with "terrific and blinding squalls of rain" at 2 A.M. The wind gradually backed to W and SW as the vessel ran before it, in front of the advancing centre, crossing the storm path, and passing from the right hand to the left hand semicircle. The lowest barometer (29·39″) was observed at 4 A.M., when the wind was from W. At 8 A.M. it had risen to 29·44″ and the wind was blowing a heavy gale from SW, with violent squalls of hail and rain. At noon, when the vessel was about 110 miles to the south-south-west of the storm centre, a very heavy gale was recorded with terrific squalls of wind and rain, the barometer falling in one of the squalls from 29·45″ to 29·39″. At midnight the barometer had risen to 29·49″, but a strong gale from SW was still blowing, although the squalls were becoming less severe and less frequent. The *Mercedes* had also run before the wind, and passed from the right hand to the left hand semicircle, crossing in front of the advancing storm. She reported that from 1 A.M. to 8 A.M., the wind blew with hurricane force (12), and gradually backed from NW to WSW. At 10 A.M., it had backed to SW with force 11, at which it remained till noon, when the vessel was about 180 miles to the south of the centre. From 4 P.M. to midnight the wind was from SW blowing with force 10. Before noon a mountainous confused sea was experienced. After noon it was reported as "less violent" and "running true," but even at midnight both wind and sea were still "terrific." From 2 A.M. to midnight the barometer rose from 29·38″ to 29·48″. The *John Pender* was also in front of the advancing storm on this day. Her barometer fell from 29·42″ at 1 A.M. to 29·20″ at midnight, and the wind backed from NW at 4 A.M. to W at 4 P.M., and gradually increased in violence from a "strong gale," with violent squalls of wind and rain and a heavy confused sea at 1 A.M., to a "terrific gale" with tremendous sea at midnight. The *Wheatfield*, which at noon was about 170 miles south-west of the centre, reported a gradual increase in the strength of the wind from a strong WSW breeze at 1 A.M. to a "whole gale" from WSW at midnight, with heavy squalls and high sea, and lightning to the eastward. The *Bessie Morris* was at noon about 210 miles south-south-east of the centre. She reported a WSW gale, force 10, at 1 A.M., with terrific squalls, much lightning and "a perfect deluge of rain." As the day advanced the weather gradually improved, and at midnight the wind had gone down to a strong breeze from SW by S, with fine weather. Her barometer rose from 29·52″ at 1 A.M. to 29·77″ at midnight. The *Inchulva* was also in the receding half of the storm circle on this day. At noon she was about 180 miles to the east-south-east of the centre. She also reported gradually improving weather, and a rising barometer, with a backing of the wind from S to SSE between 1 A.M. and 1 P.M., after which the wind veered to SSW as she passed out of the storm field to the eastward. The *Rohilla*, which at noon was about 300 miles to the east-south-east of the centre, also reported a gradual decrease in the strength of the wind from a "moderate gale" at 4 A.M. to a "moderate breeze" at 4 P.M., with a rise of the barometer from 29·61″ to 29·72″ during the same interval. Similarly, the *Mistley Hall*, which at noon was about 290 miles to the east-south-east of the centre, reported a decrease from "a gale" at 1 A.M. to a strong breeze at noon, the direction probably remaining steady at SW.

Outside the storm field proper, to the southward and beyond the isobar of 29·7″, all the vessels reported the wind to be between south and south-west, the average force being 5·7 which is ·1 greater than on the 29th. The winds on the north and north-east of Socotra were also south-westerly, and the average force as given by the observations of

four ships was 4·7, which is ·1 less than on the previous day. On the west coast of India from Ratnagiri to Karachi the winds were southerly, and strongest in the neighbourhood of Bombay, that is, in about the same latitude as the centre of the cyclone. Farther south they were light and north-westerly. The sea continued rough along the coast from Calicut to Bombay, and probably much farther northward.

The heavy rainfall was again concentrated within the storm field. Light rain had, however, fallen along the whole of the west coast of India from Cochin to Bombay, and several vessels outside the storm area to the southward and south-westward of the centre reported passing showers.

1881, May 31.—The two following tables contain all the meteorological information that has been collected for the 31st :—

TABLE XXIII.—*10 A.M., 31st May 1881.*

Station.	Barometer.	Change in 24 hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity, mean of day.					
					Miles per hour.		Per cent.	0 to 10		
	"	"	"			°	"		"	
Zanzibar . .	30·079	—·001	—·003	WSW	5	78·8	83	2	...	
Aden . . .	29·728	—·022	—·089	SSW	9	88·1	78	...	...	
Bushire . .	·589	—·075	—·091	NW	15	83·8	64	...	...	
Karachi . .	·635	—·097	—·042	S	8	90·0	70	4	...	
Bhuj . . .	·682	—·037	+·002	SW	15	93·8	48	6	...	
Rajkot . .	·710	—·028	...	SW	16	94·1	41	4	...	
Surat . .	·755	—·030	—·008	W	11	93·5	52	6	...	
Bombay . .	·801	—·001	—·002	SSW	27	89·5	68	4	0·02	Sea rough.
Ratnagiri . .	·825	—·024	+·026	SSW	...	89·6	59	6	...	
Karwar . .	·845	—·024	+·005	SW	...	85·0	76	4	1·13	Sea rough.
Mangalore . .	·884	—·009	+·031	Calm	2	83·9	79	7	1·11	
Calicut . .	·896	—·016	+·015	NNW	13	80·7	86	2	0·24	Sea rough.
Cochin . . .	·902	—·011	—·011	NW	3	84·0	83	8	1·00	
Colombo . .	·840	—·046	—·048	SW	13	85·5	74	8	0·12	
Galle . .	·837	—·037	—·041	WSW	10	82·0	91	7	0·05	

TABLE XXIV.—*31st May 1881.*

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. Africa . .	6 A.M.	...	...	29·689	...	S	...	High rolling sea from SW and clear weather.
	Noon	16° 21′ N	68° 4′ E	...	...	...	...	Do. do.
	Mid-night.	...	...	...	...	SW	...	Fresh breeze with passing showers and a high sea from SW.

Name of Vessel	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"	°			
S.S. Arabia	1 A.M.	Jask to Muscat		...	...	SE	2	Wind moderate with heavy SE swell.
	4 A.M.	...	...	29·698	85·7	SE	2	Do. do.
	8 A.M.	At Muscat		29·736	86·7	SE	2	
	Noon	...	...	...	...	SE	2	Light breeze and fine weather.
	3 P.M.	Muscat to Guadur		...	...	E by N	2	Thick mist. Light passing showers.
	4 P.M.	...	...	29·681	88·7	E by N	2	Heavy SE swell. Ship rolling heavily.
	7 P.M.	...	...	...	...	E by N	3	Increasing wind and sea. Every appearance of bad weather.
	8 P.M.	...	...	29·733	87·7	E by N	3	Moderate gale with a heavy SE swell. Ship rolling very violently.
	Midnight.	...	...	29·676	86·7	E by N	4	Ship making very heavy lurches.
S.S. Bessie Morris	1 A.M.	...	...	29·776	80·5	SW by S	6	Strong breeze and a heavy sea.
	Noon	17° 43′ N	68° 55′ E	29·818	83·5	SW by S	5	Course N 65° E. Distance 234 miles.
	1 P.M.	...	...	...	82·5	SSW	4	Moderate breeze and squally.
	5 P.M.	...	...	...	...	SSW	3	
	9 P.M.	...	...	...	...	SW	2	
	Midnight.	...	...	...	81·5	WSW	1	Squally with rain.
S. Braidwood	6 A.M.	...	...	...	...	SW	...	
	Noon	11° 44′ N	63° 52′ E	...	...	...	...	Course N 43° E.
	2 P.M.	...	...	...	...	SW	...	
	8 P.M.	...	...	...	...	...	...	Squall and heavy rain.
	Midnight.	...	...	...	...	...	...	Strong breeze and heavy swell.
S.S. Brinkburn	1 A.M.	...	...	...	...	SW	...	Light wind. Sea from southward.
	4 P.M.	...	...	...	...	S	...	Fresh wind. Sea increasing.
	Noon	14° 38′ N	57° 20′ E	...	...	SW	...	Strong wind andsea. Course E by N ½ N. Distance 216 miles.
	4 P.M.	...	...	...	...	...	...	Heavy squall.
	Midnight.	...	...	...	...	...	...	Gale. High cross sea.
S. British Crown	4 A.M.	...	...	...	...	SSW	...	
	8 A.M.	...	...	...	...	S	...	
	Noon	14° 12′ N	68° 41′ E	...	...	...	...	
	2 P.M.	...	...	...	...	S	...	Moderate breeze; sky partly cloudy.
	6 P.M.	...	...	...	...	SW by S	...	
	Midnight	...	...	...	...	...	...	Fine weather. Heavy swell.
S. Choice	Nooh	10° 47′ N	62° 55′ E	29·865	...	...	...	Course N 50° E.
	1 P.M.	...	...	...	...	SW	...	Strong steady breeze and clear sky.
	Midnight	...	...	...	...	...	...	Light breeze and high sea.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				in.	°			
S. S. Clandon	1 A.M.	...	...	...	...	SW	...	Strong breeze and heavy sea.
	4 A.M.	...	...	...	...	SW	...	Ship rolling and straining badly.
	Noon	16° 11′ N	63° 3′ E	...	...	SW	...	Ship rolling and straining badly. Course E by N ½ N. Distance 253 miles.
	4 P.M.	...	...	...	...	WSW	...	Drizzling rain and hazy weather.
	Midnight	...	...	...	...	WSW	...	Wind and sea increasing; clear weather.
S. Deva Gangadur	Noon	16° 44′ N	70° 1′ E	29·695	...	...	...	Course N 61° E. Distance 180 miles.
	2 P.M.	...	...	...	...	S	...	Fresh breeze and cloudy weather.
	Midnight	...	...	...	...	...	...	Moderate baffling winds, with showers of rain.
S. S. Eschol	8 A.M.	...	...	...	...	...	...	Heavy gale and a high sea.
	9 A.M.	...	...	...	...	SW	...	Wind moderating a little, but sea tremendously high.
	Noon	16° 15′ N	61° 50′ E	...	...	...	...	Heavy gale and a high sea. Course E. by N. Distance 222 miles.
	1 P.M.	...	...	...	...	SW	...	Strong gale and a very heavy sea.
	Midnight	...	...	...	...	...	...	Moderate gale and a strong sea.
S. Exporter	Noon	13° 55′ N	66° 58′ E	...	...	SSW	...	Moderate breeze and cloudy weather.
	9 P.M.	...	...	...	...	S	...	
S. Hindustan	8 A.M.	...	...	...	...	SW	...	Strong monsoon with bright clear weather and high sea.
	Noon	12° 14′ N	65° 15′ E	...	...	...	...	Ditto ditto Course N 41° E. Distance 204 miles.
	8 P.M.	...	...	...	...	SW	...	Wind falling lighter. Overcast at midnight.
S. S. Inchulva	1 A.M.	...	...	...	...	S to SW	...	Strong wind and a very heavy SW sea.
	Noon	18° 35′ N	67° 30′ E	...	...	S to SW	...	Strong wind and less sea, though heavy.
	10 P.M.	...	...	29·75	...	SW	...	Strong wind.
S. Iris	1 A.M.	...	...	...	...	SSW	...	Light breeze and clear weather.
	4 A.M.	...	...	...	...	...	...	Squally.
	Noon	15° 10′ N	67° 23′ E	29·727	...	...	...	Moderate breeze and hazy weather with heavy swell. Course N 28° E. Distance 153 miles.
	1 P.M.	...	...	...	...	S	...	
	3 P.M.	...	...	...	...	SW	...	Smart breeze and heavy weather.
	Midnight	...	...	...	...	...	...	Light breeze and showery weather.
S. S. John Pender	1 A.M.	...	...	...	...	W	...	Terrific gale with very severe squalls and blinding rain. Tremendously high sea. Ship labouring very heavily. Decks continually flooded. Barometer still falling.
	4 A.M.	...	...	29·20	80	...	...	
	6.30 A.M.	...	...	29·06	79	...	...	Complete hurricane with a frightful sea.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				″	°			
S.S. John Pender—contd.	1 P.M.	...	...	...	...	SW	...	Wind falling more to the south and still blowing very hard; squalls less violent and less frequent. Frighful sea.
	4 P.M.	...	...	29·15	83	...	...	Wind still blowing very hard, but not quite so fierce as in the forenoon; a very high sea.
	8 P.M.	...	...	29·25	82	SW by S	...	Weather looking a little finer.
	9 P.M.	...	...	...	...	...	...	Wind blowing as hard as ever; most terrific squalls of wind and blinding rain.
	Midnight	...	...	29·30	81	...	...	Weather very dirty. Fierce gale with a very high confused sea.
S. S. Mercedes	1 A.M.	...	...	...	...	SW	10	Violent gale and a very heavy sea with heavy rain; squalls.
	4 A.M.	...	...	...	...	SW	9	Wind less violent. Sea terrific.
	8 A.M.	...	...	29·582	...	SW by S	9	Wind moderating, but sea very heavy from SW.
	Noon	15° 42′ N	63° 57′ E	29·582	...	SW by S	9	Wind and weather unchanged; sky cloudy.
	2 P.M.	...	...	...	...	SW by S	9	Violent gale; ship labouring and straining heavily.
	8 P.M.	...	...	...	...	SW by S	9	Violent gale and heavy sea.
	Midnight	...	...	...	...	SW by S	9	Violent gale and terrific sea.
S. Mistley Hall	1 A.M.	...	...	...	...	SW by S	...	Fresh breeze and clear weather.
	Noon	17° 6′ N	68° 20′ E	29·690	...	SSW	...	Ditto ditto Course N 45° E. Distance 184 miles.
S.S. Nyanza	3 A.M.	...	...	29·973	75·3	S	4 to 5	Fresh breeze and cloudy weather; ship rolling heavily.
	7 A.M.	...	...	29·950	80·3	SSW	4 to 5	Ditto ditto
	11 A.M.	...	...	29·924	86·3	SSW	4 to 5	Fresh breeze and cloudy weather; ship rolling heavily.
	Noon.	7° 53′ N	57° 42′ E	...	...	...	...	Course N 51° E.
	3 P.M.	...	...	29·910	84·3	SW	4 to 5	Fresh breeze and cloudy weather.
	7 P.M.	...	...	29·910	80·3	SW	4 to 5	Fresh breeze with fine weather and passing clouds. High confused sea.
	11 P.M.	...	...	29·908	77·3	SW	4 to 5	Ship rolling heavily to SW swell.
S. Queen's Cliff	Noon.	12° 13′ N	65° 30′ E	...	...	SW	...	Strong breeze and clear weather; course N 53° E. Distance 196 miles.
	2 P.M.	...	...	...	...	SW	...	Strong breeze and clear weather; heavy sea; ship rolling and straining heavily.
	Midnight.	...	...	...	...	...	...	Fresh breeze and fine clear weather.
S.S. Sestos	1 A.M.	...	...	...	...	SSW to SW	...	Fresh gale; at 4 A.M. gale moderating; fine weather, but overcast; sea still very heavy.
	8 A.M.	...	...	...	...	...	...	Moderate gale with better weather.
	Noon.	17° 10′ N	63° 15′ E	29·614	78·7	SW	...	Moderate gale; weaher clearing up.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S.S. Sirdhana	1 A.M.	...	...	...	...	S	...	Moderate wind and cloudy weather with very heavy sea; ship labouring very severely.
	4 A.M.	...	...	29·703	82·7	S	...	Compelled to haul ship's head to S.
	8 A.M.	...	...	29·728	84·7	S	...	Weather unchanged.
	Noon	21° 48′ N	67° 57′ E	29·745	85·7	...	...	Course S 23° E. Distance 153 miles.
	1 P.M.	...	...	...	...	SW	...	Fresh wind and squally. High SW sea; ship labouring very severely.
	4 P.M.	...	...	29·705	85·7	...	...	Same weather.
	8 P.M.	...	...	29·715	85·7	...	...	Ditto.
	Midnight.	...	...	29·749	85·7	...	...	Ditto.
S. Slieve More	4 A.M.	...	...	...	...	SSE	...	Moderate breeze and clear weather.
	Noon.	16° 54′ N	70° 24′ E	29·800	...	SSW	...	Ditto. Course N 43° E. Distance 194 miles.
	8 P.M.	...	...	...	...	...	...	Decreasing breeze and clear weather.
S.S Tebe	4 A.M.	...	...	29·525	...	SW	6	
	8 A.M.	...	...	22·465	...	SW	7	
	Noon.	16° 19′ N	60° 54′ E	...	...	SW	7	
	2 P.M.	...	...	...	...	...	...	Very strong wind and heavy cross sea.
	4 P.M.	...	...	29·465	...	SW	6	
	8 P.M.	...	...	29·525	...	SW	6	
	Midnight.	...	...	...	...	SW	6	
S.S. Wheatfield	1 A.M.	...	...	...	...	SW by S	...	Strong wind and heavy sea with lightning and very heavy squalls of wind and rain.
	4 A.M.	...	...	...	...	...	...	Weather more moderate.
	8 A.M.	...	...	...	...	SW by S	...	Sea moderating but still very high.
	Noon.	18° 3′ N	65° 30′ E	29·583	...	...	...	Fresh breeze and fine weather.
	8 P.M.	...	...	...	...	S	...	Ditto ditto.
	Midnight.	...	...	...	...	...	...	Ditto ditto. Sea going down.
SS. Wistow Hall	1 A.M.	...	...	...	...	SW	...	Fresh breeze and hazy weather with a high sea.
	Noon.	15° 14′ N	57° 8′ E	29·614	82·2	SW	...	Ditto ditto. Course N 70° E. Distance 260 miles.
	1 P.M.	...	...	...	...	WSW	...	Moderate gale.
	8 P.M.	...	...	...	...	...	...	Overcast sky.
	Midnight.	...	...	...	...	...	...	Gale increasing.

The chart for the day, Plate XXXII, exhibits the meteorological conditions at noon. It shows that the cyclonic depression had continued to expand until the isobar of 29·5 was now about 440 miles in diameter. At noon on the 30th it was about 370 miles. On the 31st the centre had moved forward to about Lat. 19° 20′ N. and Long. 61° 32′ E. In other words, it had travelled in the preceding twenty-four hours about 158 miles in a west-

north-west direction. The lowest pressure shown on the chart is 29·0″ which has been obtained by interpolation from the log of the *John Pender*. Unfortunately, no opportunity of comparing the barometer of this vessel with a standard has presented itself, and it is therefore needful to assume that the instrument had no error. As the *John Pender* is a telegraph ship, specially employed on scientific work, it is probable that this assumption is correct. If so, the cyclone was much larger on the 31st than on any previous day, and therefore the pressure in the centre would probably be much lower than before, perhaps far below 27 inches; but, as no ship is known to have been in, or near, the centre on that day, the actual pressure there is unknown. The lowest recorded pressure is 29·96″, on the *John Pender*, at 6 hours 30 min. A.M. This is 0·77″ below the normal pressure for the time of the year, and for the position then occupied by the ship. To the south of the storm field the pressure appears to have fallen considerably, the isobar of 30·1 having disappeared, and those of 30·0″, 29·9″, and 29·8″ having receded southwards about 3°, 2°, and 1° respectively, while that of 29·7″ remained nearly stationary. Thus, the gradients between the storm field and the equator were greatly reduced. The pressure also fell somewhat along the whole of the west coast of India and in Ceylon, the fall being greatest in the extreme north and extreme south. It also fell a little at Aden and considerably at Bushire. As on the previous day, the winds were very violent inside the isobar of 29·5, increasing from a moderate gale (force 7) on that isobar to a complete hurricane (force 12) near the centre of the cyclone. Between the isobars of 29·5 and 29·7 the average force of the wind given by the observations of seven ships was 6·0. Outside the storm field and outside the isobar of 29·7″ to the south and south-east of the centre the winds were all south-westerly, with an average force, as determined from the observations of thirteen ships, of 4·8, which is ·9 less than on the 30th. This accords with the above mentioned decrease of the barometric gradients over the same area. The *John Pender* is the only vessel known to have been near the centre on this day. At 1 A.M. she experienced a terrific gale from W, with severe squalls and "blinding rain," and a tremendously high sea, with a falling barometer. At 6-30 A.M. the barometer had fallen to 29·06″, and the wind had risen to a "complete hurricane," with a "frightful sea." At 1 P.M. the wind had backed to SW and the squalls had become less violent and frequent, although a "frightful sea" was still running. At 4 P.M. the barometer stood at 29·15″, the wind was "still blowing very hard," although it was not quite so fierce as in the forenoon, and the sea continued very high. At 8 P.M. the barometer had risen to 29·25″, but at 9 P.M. the wind was blowing as hard as ever, with most terrific squalls of wind and "blinding rain." At midnight a fierce gale, a very high confused sea, and a barometer reading of 29·30″ were recorded. The *Tebe*, the *Eschol* and the *Sestos*, all on the south side of the cyclone, about 200 miles from the centre, reported gales or very strong winds before noon, and gradually improving weather, as the day advanced. The *Clandon*, the *Mercedes* and the *Wheatfield*, which were in the south-east quadrant of the cyclone, between 250 and 300 miles from the centre, reported a similar improvement in the state of the weather. On the contrary, the *Brinkburn* and the *Wistow Hall*, which at noon were about 400 miles to the south-west of the centre, steaming eastward, and therefore getting nearer to the centre, both reported a gradual increase in the strength of the wind from a fresh breeze in the early morning to a gale at midnight, with the usual high sea and squally weather. The *Arabia*, which at noon was at Muscat, about 330 miles to the NNW of the centre, and which in the afternoon was sailing thence to Guadur on the Mekran coast, reported that at 7 P.M. the wind and sea were increasing with every

appearance of bad weather. At 8 P.M. a "moderate gale" from E by N and a heavy south-east swell were recorded. In this case also, the sea came from a direction several points to the right of the wind.

About 500 miles from the centre of the cyclone, and to the south-east of it, the winds were a little more southerly than at the same distance to the south, thus showing the tendency of the cyclone to draw the air towards the centre, even from so great a distance as 500 miles. On the west coast of India the strength of the wind was now but very slightly affected by the cyclone. Only at Bombay was it unusually strong. Its direction, however, along the whole of the coast from Ratnagiri northward to Karachi, was generally more southerly than the normal direction, and it is probable that this deflection was due to the influence of the cyclone. From Karwar southward the winds were of the normal type. The distribution of the rainfall shown by the chart indicates no concentration of rain in the storm field, but this is doubtless because very few ships happened to be near the centre on this day. The log of the *John Pender* suffices to show that very heavy rain fell near the centre, for twice during the day the entry "blinding rain" appears. No other vessel was near the centre, and no other recorded unusually heavy rain. There was, however, general and moderate rain to the south and south-east of the centre, and along the west coast of India from Cochin to Karwar. Along the whole of the coast from Calicut to Bombay the sea continued rough.

1881, June 1st.—The meteorological information for this day is contained in the following tables:—

TABLE XXV.—*10 a.m., 1st June 1881.*

Station.	Barometer.	Change in 24 hours.	Abnormal.	Wind.		Thermometer.	Relative Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity mean of day.					
	in.	in.	in.		Miles per hour.	°	Per cent.	0 to 10	in.	
Zanzibar	30·063	—·011	—·017	SW	5	77·7	84	4	0·09	
Aden	29·686	—·042	—·128	S	9	88·0	74	...	...	
Bushire	·547	—·042	—·127	NW	19	82·8	60	...	...	
Karachi	·655	+·020	—·018	SW	15	89·0	71	2	...	
Bhuj	·652	—·030	—·025	SW	17	92·6	47	5	...	
Rajkot	·681	—·029	—·026	WNW	19	93·5	39	6	...	
Surat	·735	—·020	—·025	W	23	91·5	57	5	...	
Bombay	·784	—·017	—·016	WSW	13	88·7	75	4	0·15	Sea moderate.
Ratnagiri	·807	—·018	+·009	WSW	...	86·5	83	3	0·60	p.
Karwar	·811	—·034	—·028	SW	...	81·1	86	10	0·47	Sea very rough, f. d. r.
Mangalore	·813	—·071	—·041	NNW	3	82·4	83	9	1·20	
Calicut	·827	—·069	—·055	NNW	9	81·7	82	3	0·06	Sea rough.
Cochin	·824	—·078	—·070	NW	3	84·0	83	10	0·10	
Colombo	·814	—·026	—·074	SW	15	84·5	77	8	...	
Galle	·802	—·035	—·076	WNW	10	82·5	91	6	0·07	

TABLE XXVI.—*1st June 1881.*

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"	°			
S. Africa	Noon	16° 35′N	68° 24′E					
S.S. Arabia	1 A.M.	Muscat to Guadur		...	...	E	4	Strong wind and cloudy weather with heavy SE swell.
	4 A.M.	...	...	29·646	86·7	E	4	Ship labouring and rolling very violently.
	8 A.M.	...	...	29·726	86·7	E	4	Fresh gale and fine weather. Heavy SE swell, ship rolling and pitching most violently.
	Noon	...	...	29·766	86·7	E	4	Same weather with haze on horizon.
	4 P.M.	...	...	29·696	86·7	E	3	Strong breeze and hazy weather. Heavy head sea and tremendous cross swell rolling up from S. Ship labouring and rolling most violently.
	8 P.M.	...	...	29·815	86·7	E	3	Sea increasing. Ship rolling and lurching more violently than before.
	Midnight.	...	...	29·781	84·7	E	3	Less wind but tremendous sea rolling up from S.
S. Braidwood	4 A.M.	...	...	...	...	SW	...	
	Noon	14° 19′N	66° 26′E	...	...	...	...	Course N 44° E.
	2 P.M.	...	...	...	...	SW	...	Strong breeze.
	Midnight.	...	...	...	...	SE	...	Light wind.
S.S. Brinkburn	1 A.M.	...	...	...	...	S	...	Strong gale and heavy sea.
	Noon	16° 0′N	60° 21′E	...	...	...	...	Strong gale. Heavy sea continually filling the decks. Course E by N½ N. Distance 225 miles.
	2 P.M.	...	...	...	...	...	...	Heavy sea burst bulwark of lower bridge and washed it away.
	8 P.M.	...	...	...	...	...	...	Moderate gale.
	Midnight.	...	...	...	...	...	...	Wind and sea more moderate.
S. British Crown	6 A.M.	...	...	...	...	SW¼W	...	
	Noon	15° 36′N	70° 12′E					
	2 P.M.	...	...	...	...	SW by W	...	Moderate breeze and fine weather.
	Midnight.	...	...	...	...	WSW	...	Fresh breeze and partly cloudy.
S. Canute	4 A.M.	...	...	...	...	SE	...	Moderate breeze. Dark heavy clouds to SE.
	8 A.M.	...	...	...	...	SSE		
	Noon	1° 15′ N	64° 10′ E	30·054	...	...	...	Moderate breeze and hazy weather. Course N 30° E. Distance 131 miles.
	2 P.M.	...	...	....	....	SE	....	Moderate breeze and hazy weather.
	8 P.M.	...	...	...	...	SSE	...	Heavy showers of rain.
	Midnight.	...	...	...	...	...	...	Moderate breeze and heavy rain.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				in.	°			
S. Choice	Noon	12° 53′ N	65° 9′ E	29·865	...	SW	...	Course N 48° E.
	1 P.M.	...	...	...	...	SW	...	Light wind and high sea. Ship rolling very heavily at times.
	8 P.M.	...	...	...	...	SWbyW	...	
S.S. Clan Macleod	1 A.M.	...	...	...	...	Calm	...	Fine clear weather and smooth sea.
	8 A.M.	...	...	...	...	S	...	Light breeze and clear weather.
	10 A.M	...	...	...	...	SW	...	Breeze freshening and sea rising.
	Noon	13° 4′ N	47° 24′ E	...	...	SW	...	Fresh breeze and confused sea. Course N 80° E. Distance 205 miles.
	1 P.M.	...	...	...	...	SW	...	Fresh breeze and hazy weather. Ship rolling heavily.
	8 P.M.	...	...	...	...	W by S	...	Light breeze and fine weather.
S.S. Clandon	1 A.M.	...	...	...	...	SW	...	Strong breeze and clear weather.
	6 A.M.	...	...	...	...	SW	...	Squally with rain and strong sea.
	Noon	17° 52′ N	66° 50′ E	...	...	SW	...	Fine steady breeze and clear weather.
	8 P.M.	...	...	...	...	SW	...	Same wind and weather.
S.S. Coniston	Noon	6° 36′ N	78° 2′ E	...	...	WNW	...	Strong wind and heavy cross sea, with heavy squalls of rain.
S. Deva Gangadur	Noon	17° 48′ N	71° 45′ E	29·693	...	...	...	Light breeze and cloudy weather. Course N 56° E. Distance 120 miles.
	2 P.M.	...	...	...	...	SW	...	Moderate breeze and passing showers of rain.
S.S. Eschol	1 A.M.	..	...	...	...	SW	...	Shipped a heavy sea.
	8 A.M.	...	...	...	...	SW	...	Fresh gale, but less wind and sea.
	Noon	17° 10′ N	65° 25′ E	...	...	...	...	Moderate gale.
	1 P.M.	...	...	...	...	SW	...	Moderate gale with a high sea.
	4 P.M.	...	...	...	...	S	...	Fresh breeze.
	8 P.M.	...	...	...	...	...	...	Moderate breeze.
	Midnight.	...	...	...	...	...	...	Moderate breeze and a heavy swell. Fine clear weather.
S. Exporter	7 A.M.	...	...	...	...	SSW	...	
	Noon	15° 58′ N	68° 0′ E	...	...	SW	...	Moderate breeze and clear weather.
S. Hindustan	4 A.M.	...	...	...	...	SW	...	Fine clear weather.
	Noon	14° 23′ N	67 °6′ E	...	...	...	...	Course N 40° E. Distance 168 miles.
S.S. Inchulva	1 A.M.	...	...	...	...	SW to W	...	Light wind and fine weather. Sea much less.
	Noon	18° 31′ N	70° 59′ E	...	...	W	...	Light wind. Course NE by E ½ E. Distance 177 miles.
S. Iris	2 A.M.	...	...	...	...	SW	...	Light breeze and showers of rain.
	4 A.M.	...	...	...	...	SW	...	Light breeze and hazy weather.
	Noon	16° 32′ N	69° 8′ E	29·727	...	SW	...	Light breeze and cloudy weather. Course N 51° E.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. Iris.—contd.	Midnight.	...	...	...	...	SW	...	Moderate breeze and passing showers.
S.S. John Pender	1 A.M.	...	...	...	...	SW by W	...	Strong gale and high sea. Heavy squalls of wind and rain.
	3 A.M.	...	...	29·35	81	WSW	...	Hard gale with tremendous sea and terrific squalls of wind and rain. Ship labouring and rolling heavily. Decks completely deluged with water at times.
	8 A.M.	...	...	29·46	82	...	...	
	Noon	...	...	29·50	82	...	...	Wind seems a little more moderate. Squalls less frequent and less violent.
	1 P.M.	...	...	...	...	WSW	...	Strong gale with high sea. Heavy weather.
	4 P.M.	...	...	29·45	81	SW	...	Gale more moderate, but still very high.
	8 P.M	...	...	29·52	80	...	...	Wind and sea increasing; blowing hard; heavy squalls.
	Midnight.	...	...	29·50	82	SSW	...	Dark and dreary.
S.S. Mercedes	1 A.M.	...	...	...	...	SW by S	8	Violent gale and a heavy confused sea. Ship labouring and straining heavily. Every thing moveable washed off the decks.
	Noon	15° 50′ N	62° 33′ E	29·422	89·1	SW by S	8	No improvement in the weather. Course N 84° W. Distance 102 miles. Decided to return to Bombay.
	8 P.M.	...	...	...	...	SW by S	8	Violent gale with a heavy sea.
	Midnight	...	...	...	...	SW by S	8	Occasional squalls of rain.
S. Mistley Hall	1 A.M.	...	...	...	...	S	...	Moderate breeze and fine weather.
	8 A.M.	...	...	...	...	WSW	...	
	Noon	18° 11′ N	70° 47′ E	...	...	WSW	...	Course N 59° E. Distance 144 miles.
S.S. Nyanza	3 A.M.	...	...	29·898	77·3	SW	4 to 5	Fresh breeze and cloudy weather. Ship rolling heavily to SW swell.
	7 A.M.	...	...	29·872	87·3	SW	4 to 5	Ditto ditto.
	11 A.M.	...	...	29 879	88·3	SW	4 to 5	Ditto ditto.
	Noon	10°2 2′ N	61° 17′ E	...	...	...	...	Course N 52° E. Distance 270 miles.
	3 P.M.	...	...	29·857	85·3	SW	5 to 6	Strong breeze and fine weather. High SW swell. Ship rolling heavily.
	7 P.M.	...	...	29·852	83·3	SW	5 to 6	Ditto ditto.
	11 P.M.	...	...	29·843	79·3	SW	4 to 5	Fresh breeze and fine weather.
S. Queen's Cliff	Noon	14° 0′ N	67° 37′ E	...	...	...	...	Light breeze. Course N 49°E. Distance 164 miles.
	2 P.M.	...	...	...	...	SW	...	Light breeze and fine clear weather.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S.S. Sestos	1 A.M.	...	...	...	...	SSW	...	Gale moderating. Weather clearing up.
	Noon	17° 2′ N	63° 32′ E	29·674	...	...	...	
S.S. Sirdhana	4 A.M.	...	...	29·711	83·7	SW	...	Wind and sea moderating.
	8 A.M.	...	...	29·748	84·7	SW	...	
	Noon	19° 23′ N	70° 49′ E	29·748	84·7	SW	...	Moderate wind and cloudy weather. Course S 48° E. Distance 216 miles.
	4 P.M.	...	...	29·745	85·7	SW	...	Ship rolling heavily at times.
	8 P.M.	...	...	29·743	86·7	SW	...	
	Midnight	...	...	29·775	85·7	SW	...	
S. Slieve More	4 A.M.	...	...	...	...	SSW	...	
	9 A.M.	...	...	...	...	SW	...	
	Noon	18° 20′ N	72° 24′ E	29·820	...	W	...	Light breeze and heavy swell. Course N 52° E. Distance 145 miles.
	4 P.M.	...	...	...	...	W	...	Moderate breeze and clear weather.
S.S. Tebe	4 A.M.	...	...	...	...	SSW	4	
	8 A.M.	...	...	29·554	...	SSW	4	
	Noon	16° 47′ N	64° 24′ E	29·574	...	SSW	4	
	4 P.M.	...	...	29·594	...	SSW	4	
	8 P.M.	...	...	29·633	...	SSW	2	
	Midnight.	...	...	29·743	...	SSW	2	
S.S. Tenasserim	4 A.M.	...	...	29·655	84·7	SW by W	4 to 5	Vessel rolling heavily.
	8 A.M.	...	...	29·702	83·7	SW	4	Fresh breeze.
	Noon	20° 43′ N	69° 52′ E	29·699	84·7	SW	3 to 4	Course N 54° W. Distance 186 miles.
	4 P.M.	...	...	29·642	85·7	SW	4 to 5	Heavy SW swell.
	8 P.M.	...	...	29·635	84·7	SW	5	Fresh breeze.
	Midnight.	...	...	29·667	83·7	SW	3 to 4	Heavy SW swell.
S.S. Wheatfield	1 A.M.	...	...	...	...	S	...	Fresh breeze and fine weather.
	7 A.M.	...	...	...	...	...	...	Fresh breeze and cloudy weather; light rain.
	Noon	18° 23′ N	68° 57′ E	...	...	...	...	Fresh breeze and fine weather. Course E by N.
	Midnight.	...	...	...	...	...	...	Light breeze and fine weather with SW swell.
S.S. Wistow Hall	1 A.M.	...	...	...	...	WSW	...	Fresh gale and a high sea.
	4 A.M.	...	...	...	...	SW	...	Hurricane and tremendous high sea.
	4-30 A.M.	...	...	...	...	SW	...	A perfect hurricane. Two boats carried away.
	6 A.M.	...	...	...	...	SW	...	Brought ship's head to wind and sea, and eased engines.
	9 A.M.	...	...	...	...	SW	...	Ship pitching tremendously and shipping heavy seas, doing much damage.
	Noon	16° 52′ N	60° 8′ E	...	...	SW	...	

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
S.S. Wistow Hall—contd.	3 P.M.	...	...	...	...	SW	...	Wind changed to moderate. Kept ship away before the wind.
	4 P.M.	...	...	...	...	SW	...	Strong gale and high sea.
	8 P.M.	...	...	...	...	SSW	...	Fresh breeze and overcast sky.
	11 P.M.	...	...	...	...	SSW	...	Less wind and decreasing sea with heavy showers of rain.

The meteorological conditions at noon are represented by the chart for the day, Plate XXXIII, which shows that the cyclonic depression of the barometer had now begun to fill up, the diameter of the isobar of 29·5 having contracted from about 440 miles to about 330 miles during the preceding twenty-four hours. The centre of the depression had now moved to about Lat. 19° 50′ N and Long. 60° 15′ E, having travelled in the course of the day about 93 miles in a west-north-west direction. The lowest pressure marked on the chart is 29·50″. This was observed on the *John Pender* at noon, but at 3 A.M., the same ship reported a pressure of 29·35″, which is ·48″ below the normal pressure, and the lowest recorded by any vessel on the 1st of June. As the storm passed towards the north-north-west, and began to fill up, the pressure in the rear of it rapidly increased. In the south of the Arabian Sea, however, the pressure remained nearly stationary, while on the west coast of India it fell slightly, and in Ceylon more considerably. These changes of pressure produced a great decrease of the barometric gradients to the south and south-east of the storm field, and accordingly, as will presently be seen, the strength of the winds over this region rapidly decreased. At Aden and Bushire the pressure also fell somewhat, and at both stations it was now about an eighth of an inch below the normal. No vessels are known to have been very near the centre of the cyclone on this day. The *John Pender* was the nearest, and she no doubt experienced the roughest weather. At noon she was probably about 160 miles to the south-west of it. At 1 A.M., she reported a strong gale and high sea, with heavy squalls of wind and rain; at 3 A.M., a hard gale from WSW. and a tremendous sea, with terrific squalls of wind and rain and a barometer reading of 29·35″. At noon, the barometer had risen to 29·50″, the wind had moderated a little, and the squalls were becoming less frequent and violent. At 4 P.M., the wind backed to SW but was still very high, and by midnight it had backed to SSW. These changes of direction show that the storm was passing to the northward of the vessel from east to west. The *Wistow Hall* was a little farther from the centre at a distance of about 20 miles due south at noon. She also reported a gradual backing of the wind from WSW to SW between 1 A.M., and 8 P.M. At 1 A.M., a fresh gale and a high sea were recorded; at 4 A.M., a hurricane and tremendous sea; at 4h, 30m. A.M. a "perfect hurricane, in which two boats were carried away. At 6 A.M., the ship's head was brought to the wind and sea, and the engines were eased. At 3 P.M., the wind moderated and the ship was "kept away before the wind." At 4 P.M., a strong gale and a high sea were recorded. At 8 P.M., it had fallen to a fresh breeze, and at 11 P.M. there was less wind and a decreasing sea with heavy showers of rain. The *Brinkburn*, still farther to the south of the centre, at a distance of about 260 miles at noon, reported a strong southerly gale with

heavy sea from 1 A.M., to noon, falling to a moderate gale at 8 P.M., and to a more moderate wind by midnight. The *Mercedes*, which at noon was about 320 miles to the south-south-east of the centre reported a violent gale from SW by S, force 8, and a heavy confused sea, which continued all day with occasional squalls of rain. The *Sestos*, about 300 miles to the south-west of the centre, reported a moderate gale from SSW and the weather clearing up. The *Tebe*, about 50 miles farther away from the centre, and in the same direction from it, reported a gradual rise of the barometer from 29·55″ at 8 A.M. to 29·74″ at midnight, with the wind steady from SSW, but decreasing in force as the day advanced. And the *Eschol*, about 400 miles to the east-south-east of the centre, reported a fresh gale at 8 A.M.; a moderate gale with a high sea at 1 P.M.; a fresh breeze from S at 4 P.M., and a moderate breeze with fine clear weather and a heavy swell at midnight, showing a gradual improvement in the weather throughout the day.

Outside the isobar of 29·7″ between south and east of the centre, the average force of the wind, as determined from the noon observations of thirteen ships, was 3·2, which is 1·6 lower than on the previous day. The direction of these winds was SSE near the equator; SW between lat. 10° N and 16° N, and more westerly about lat. 18° N. On the west coast of India, from Karachi to Karwar, the winds were south-westerly. To the south of Karwar they were light and north-westerly.

The heaviest rainfall was observed by those vessels nearest the centre. Most of those outside the isobar of 29·6″, and between the centre and the Bombay Coast, reported fine weather, only three out of twenty-one having recorded passing showers or light rain One vessel, the only one near the equator, reported heavy rain. Light to moderate rain fell along the west coast of India from Cochin to Bombay, but to the northward of Bombay none was recorded.

1881, June 2nd.—The two following tables contain the available information for this day:—

TABLE XXVII.—*10 A.M., 2nd June 1881.*

Station.	Barometer.	Change in twenty-four hours.	Abnormal.	Wind.		Thermometer.	Relative humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity mean of day.					
	″	″	″		Miles per hour.	°	Per cent	0 to 10	″	
Zanzibar	30·092	+ ·024	+ ·004	SW	4	77·5	84	7	0·08	
Aden	29·734	+ ·048	— ·077	SSW	8	91·7	65	...	...	
Bushire	·593	+ ·046	— ·075	NW	12	89·8	47	...	...	
Karachi	·655	0	— ·014	SW	15	90·0	73	1	...	
Bhuj	·660	+ ·008	— ·014	W	17	93·0	45	8	...	
Rajkot	·685	+ ·004	— ·018	W	18	95·5	36	4	...	
Surat	·752	+ ·017	— ·005	W	17	87·6	55	4	0·04	
Bombay	·784	0	— ·014	W	13	89·1	69	5	0·12	Sea slight.
Ratnagiri	·808	+ ·001	+ ·012	W	...	87·5	68	5	0·35	P.
Karwar	·809	— ·002	— ·029	N	...	84·0	77	6	0·29	Sea very rough.
Mangalore	·849	+ ·036	— ·005	WNW	8	84·4	74	8	0·58	
Calicut	·841	+ ·014	— ·041	NNW	10	82·7	82	4	0·60	Ditto.
Cochin	·855	+ ·031	— ·037	NNE	3	85·0	79	10	2·20	
Colombo	·778	— ·036	— ·010	WSW	15	84·0	79	9	0·12	
Galle	·796	— ·006	— ·082	NW	12	83·0	91	7	0·17	Strong wind.

TABLE XXVIII.—*2nd June 1881.*

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"	°			
S. Africa	Noon	16° 40′ N	69·36′ E	...	...	W	...	Fresh breeze and passing showers of rain.
S.S. Arabia	1 A.M.	Muscat to Karachi		...	...	SE	3	Fresh wind with continued heavy swell from S.
	4 A.M.	...	...	29·784	83·7	SE	3	Ship rolling very violently.
	8 A.M.	...	...	29·800	84·7	SE	2	Wind decreased to a light breeze, tremendous swell from S, and thick haze on the horizon.
	Noon	...	...	29·820	84·7	SE	2	Light wind; with same high swell from S.
	1 P.M.	...	...	...	...	SSE	2	Light wind gradually veering to S with hazy weather. High swell veering round to SSW and SW.
	4 P.M.	...	...	...	...	SSE	2	Very severe rolling continues.
	8 P.M.	...	...	...	...	S	2	Clear weather with hazy horizon. Heavy swell from SW.
	Midnight	...	...	29·798	85·7	S	2	Light wind with heavy SW swell.
S. Braidwood	8 A.M.	...	...	...	...	SW	...	
	Noon	15° 32′ N	67° 44′ E	...	...	...	...	Course N 45° E.
S.S. Brinkburn	1 A.M.	...	...	...	...	SW	...	Moderate wind and sea.
	4 A.M.	...	...	...	...	...	...	Weather clearing up.
	Noon	17° 3′ N	64° 15′ E	...	...	...	...	Fine steady breeze. Course E by N ½ N. Distance 220 miles.
	Midnight	...	...	...	...	...	...	Light wind and clear weather.
S. British Crown	6 A.M.	...	...	...	...	W	...	
	Noon	17° 18′ N	71° 47′ E	...	...	...	...	
S. Choice	Noon	14° 18′ N	66° 46′ E	...	...	...	...	Course N 49° E. Distance 149 miles.
	1 P.M.	...	...	...	...	SW by W	...	Fresh steady breeze.
	4 P.M.	...	...	...	...	...	...	Sea smoother.
	8 P.M.	...	...	...	...	WSW	...	
S. Clan Macleod	1 A.M.	...	...	...	...	WSW	...	Sea rough. Light breeze and clear weather.
	4 A.M.	...	...	29·698	...	...	...	Increasing breeze and cross sea.
	8 A.M.	...	...	...	...	...	...	Strong breeze and hazy weather. Ship rolling heavily and taking much water on deck.
	Noon	13° 43′ N	51° 32′ E	...	...	...	...	Course N81° E. Distance 247 miles.
	1 P.M.	...	...	...	...	WSW	...	Sea rough. Fresh breeze and confused sea.
	6 P.M.	...	...	...	...	SSW	...	Heavy sea. Ship rolling heavily.
	10 P.M.	...	...	...	...	...	...	Strong breeze with high sea.
S.S. Coniston	Noon	7° 49′ N	75° 39′ E	...	...	WNW	...	Strong wind and heavy cross sea, with heavy squalls of rain.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind. Direction.	Wind. Force.	Remarks.
				"	"			
S.S. Euphrates	4 A.M.	...	...	...	...	SSW	...	Moderate breeze with a heavy swell. Fine weather and clear sky.
	10 A.M.	...	...	...	...	SW	...	Fine weather and clear sky. Moderate breeze with a heavy swell.
	Noon	18° 10′ N	68° 50′ E	...	...	...	...	Moderate breeze with a heavy swell.
	2 P.M.	...	...	...	...	SW	...	Moderate breeze with a heavy SW swell.
	6 P.M.	...	...	...	...	WSW	...	Ditto ditto.
	10 P.M.	...	...	...	...	W by S	...	Ditto ditto.
S.S. Hertville	2 A.M.	...	...	...	...	Variable	...	Variable light airs and calms.
	8 A.M.	...	...	...	...	SW	...	Increasing breeze.
	Noon	13° 46′ N	47° 53′ E	...	...	SW	...	Brisk breeze and increasing sea. Course N87° E. Distance 107 miles.
	4 P.M.	...	...	...	...	SW	...	Strong breeze and increasing sea.
	8 P.M.	...	...	...	...	SW	...	Decreasing breeze and falling sea.
	Mid. 4 A.M.	...	...	...	...	...	...	Light variable breeze and cloudy weather.
S. Isis	2 A.M.	...	...	...	...	SW	...	Moderate breeze with passing showers.
	6 A.M.	...	...	...	...	WSW	...	
	Noon	15° 14′ N	57° 58′ E	29·77	...	...	...	Fine weather. Course N45° E. Distance 144 miles.
	Mid. 4 A.M.	...	...	...	...	...	...	Light breeze and hazy weather.
S.S. John Fowler	2 A.M.	...	...	...	...	SW by S	...	Strong gale. Squally with rain. Shipping water constantly over all.
	4 A.M.	...	...	29·49	83	...	...	Wind and sea moderating.
	6 A.M.	...	...	...	...	...	...	Squared yards and kept away to NW by N.
	8 A.M.	...	...	29·52	81	...	...	Fresh gale and high sea.
	Noon	14° 15′ N	64° 30′ E	29·53	84	SSW	...	Weather moderating. Sea still very high.
	6 P.M.	...	...	29·49	86	...	...	Strong breeze and a high sea from 3 P.M. to 6 P.M. Dark and gloomy to westward.
	Mid. 4 A.M.	...	...	29·53	81	...	...	Blowing hard, and very squally and dirty.
S.S. Hesperia	2 A.M.	...	...	...	...	SW by S	8	Strong gale and heavy sea with squalls of rain.
	6 A.M.	...	...	...	...	...	...	Sea occasionally coming on board with great violence.
	8 A.M.	...	...	...	...	SW by S	7	Wind and sea more moderate.
	Noon	16° 37′ N	65° 14′ E	29·793	84·1	SW by S	7	Moderate gale and sea. Decks continually full of water. Sky clear. Course N76° E. Distance 180 miles.
	8 P.M.	...	...	...	...	SW by S	7	Wind and sea moderate.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S.S. Nyanza	3 A.M.	...	...	29·843	79·3	SW	4 to 5	Moderate breeze and fine weather with passing clouds. Ship rolling heavily.
	7 A.M.	...	...	29·850	84·3	SW	3 to 4	Ditto ditto.
	11 A.M.	...	...	29·849	88·3	SW	3 to 4	Ditto ditto.
	Noon	13° 17′ N	65° 3′ E	...	...	SW	3 to 4	Ditto ditto. Course N 48° E. Distance 278 miles.
	3 P.M.	...	...	29·854	86·3	SW	2 to 3	Fresh breeze and fine weather. Ship rolling heavily to SW swell.
	7 P.M.	...	...	29·862	83·3	...	...	Ditto ditto.
	11 P.M.	...	...	29·878	81·3	...	...	Ditto ditto.
S. Queen's Cliff	Noon	15° 17′ N	69° 0′ E	...	...	...	...	Light breeze and clear weather. Course N 46° E, distance 111 miles.
	2 P.M.	...	...	...	...	SW	...	Light breeze and fine clear weather.
	6 P.M.	...	...	...	...	WSW	...	
	10 P.M.	...	...	...	...	W	...	Fresh breeze.
S.S. Tenasserim	1 A.M.	...	...	...	...	SW	4	Long SW swell. Vessel rolling heavily.
	4 A.M.	...	...	29·607	83·7	SW by W	5	Breeze freshening.
	8 A.M.	...	...	29·675	84·7	WSW	4 to 5	Fresh breeze.
	Noon	23° 26′ N	67° 42′ E	29·667	83·7	WSW	2 to 4	Heavy SW swell. Course N 38° E. Distance 195 miles.
	4 P.M.	...	...	29·575	84·7	WSW	4	
	8 P.M.	...	...	29·597	83·7	SW	4 to 5	
	Mid-night.	...	...	29·637	83·7	SW	2 to 3	
S.S. Wistow Hall	1 A.M.	...	...	...	...	SSW	...	Fresh breeze and showery weather with less sea.
	10 A.M.	...	...	...	...	SSE.		
	Noon	18° 33′ N	63° 56′ E	29·712	80·2	...	...	Strong gale and heavy sea with hazy horizon. Course N 65° E; distance 240 miles.
	1 P.M.	...	...	...	...	S	...	Fresh breeze and hazy weather with heavy swell.
	6 P.M.	...	...	...	...	SSW		
	Mid-night.	...	...	...	...	...	...	Strong breeze and heavy southerly swell.

The chart for the day, Plate XXXIV, depicts the meteorological conditions at noon, so far as they can be ascertained from the somewhat meagre data available from the neighbourhood of the storm centre. It shows the centre still farther to the west-north-west in about Lat. 20° 33′ N, and Long. 58° 52′ E, close to the Arabian coast. Hence it appears that the centre had travelled about 104 miles during the preceding twenty-four hours. The diameter of the isobar of 29·5″, as shown on the chart, is about the same as on the previous day, *viz.* 330 miles, but as the isobars are to a great xetent conjectural,

on account of the paucity of the observations, it is by no means certain that the cyclone did not really contract considerably between the 1st and 2nd. The evidence as far as it goes, however, seems to imply that on the 2nd the storm was of about the same dimensions as on the 1st. The lowest pressure recorded on the 2nd was 29·49″ at 4 A.M. on the *John Pender*. This is ·32″ below the normal pressure for the day and for the position then occupied by the ship; a lower reading than this, *viz.* 29·30″, is entered in the log at midnight, but, as it is very doubtful, it has been disregarded. In the rear of the cyclone the pressure rose rapidly as the centre moved away to the west-north-west, but there is no evidence of any considerable change of pressure in the south of the Arabian Sea. Along the west coast of India there was a slight rise of about ·03″ from Mangalore to Cochin, but farther northward, as far as Karachi, the change was very trifling. No ship is known to have been near the centre of the cyclone on this day, and the *John Pender* is the only one that was well within the storm field. At noon she was about 200 miles to the south-east of the centre. At 1 A.M. a strong gale was reported with squalls and rain. At 4 A.M. the wind and sea were moderating. At 8 A.M. there was a fresh gale. At noon the weather had moderated further, but the sea was still very high. At 6 P.M. a strong breeze and a high sea were recorded, with a dark gloomy appearance to the westward. The *Wistow Hall* was, at noon, about 370 miles to the east-south-east of the centre. At 1 A.M. she recorded a fresh breeze from SSW, with showery weather and less sea; at noon, a strong gale and a heavy sea with a hazy horizon; at 1 P.M., a fresh breeze and hazy weather with a heavy swell; and at midnight a strong breeze and a heavy southerly swell. The *Arabia* was on the north-east side of the storm field, about 380 miles from the centre, at noon, on the voyage from Muscat to Karachi. At 1 A.M. she reported a fresh wind from SE, with a continuous heavy swell from S, that is to say, from four points to the right of the wind. At 8 A.M. the wind fell to a light breeze, but the tremendous swell from S continued, with thick haze on the horizon. At 1 P.M. the wind veered to SSE, and at 8 P.M. to S, the heavy swell continuing but gradually veering in advance of the wind to SSW and SW. The *Brinkburn*, which at noon was about 430 miles to the south-west of the centre, reported the weather to be clearing up; and the *Mercedes*, about 70 miles farther away from the centre, reported a strong gale from SW, by S, and a heavy sea with squalls and rain at 1 A.M.; a moderate gale from the same direction with a clear sky at noon, and the same wind with a moderate sea at 8 P.M. The rise of pressure in the rear of the cyclone considerably reduced the barometric gradients on the south-east side of it outside the cyclone proper, and the winds in this region should therefore have been weaker than on the 1st. The mean force, however, given by the noon observations of eight vessels was 4·1, which is ·9 stronger than before. This is an anomaly for which no sufficient explanation readily presents itself. On the west coast of India the winds were westerly from Ratnagiri to Karachi, and north-westerly from Karwar to Cape Comorin. In the middle of the Arabian Sea, in Lat. 3° N the wind was southerly; between latitudes 13° N and 17° N it was south-westerly, and on approaching the land between latitudes 16° N and 23° N it became westerly. In the Gulf of Aden it was south-westerly. Evidently normal monsoon winds were now fully established over the greater part of the Arabian Sea.

Rain was recorded by the only two ships that were within the storm field; by one in the extreme south of the Arabian Sea, and by one off Cape Comorin, but by only two out

of twelve vessels between the storm field and the Bombay coast. On the western coast, however, from Bombay to Galle, rain was general. It was heaviest between Mangalore and Cape Comorin. At Bombay the sea had fallen much, and the influence of the cyclone upon it had disappeared, but to the southward, from Karwar to Calicut, the sea continued very rough in consequence of the establishment of the ordinary monsoon conditions in that locality.

3rd June 1881.—The following tables contain the available information for the 3rd. It is too meagre to show the general distribution of pressure over the Arabian Sea, and there is no evidence of the existence of the cyclone on this day, no information being available from that part of the Arabian Sea where the cyclone was traceable on the 2nd. It is probable that it broke up on reaching the land, for if it had continued on its west-north-west track, there would probably have been some indication of it in the observations recorded at Bushire. There is, however, no such indication, for the barometer at that station was lowest on the 1st June, after which it rose a little and remained nearly steady *for about a week; and the wind remained steady at NW from the 28th May to the 9th* June; whereas, if the cyclone had passed inland and had not broken up, the barometer would have fallen and the wind would have veered to N and NE. The available information shows, as far as it goes, that the normal monsoon conditions had established themselves over the eastern, southern, and western parts of the Arabian Sea. For the central and northern parts there are no data.

TABLE XXIX.—*10 A.M. 3rd June 1881.*

Station.	Barometer.	Change in 24 hours.	Abnormal.	Wind.		Thermometer.	Humidity.	Cloud.	Rainfall.	Remarks on the weather at 10 A.M.
				Direction.	Velocity mean of day.					
	"	"	"		Miles per hour.	°	Per cent.	0 to 10	"	
Zanzibar . .	30·117	+·025	+·026	SW	7	77·7	80	1	...	
Aden . .	29·748	+·014	—·060	NE	8	91·7	69	...	...	
Bushire . .	·626	+·033	—·036	NW	7	80·8	55	...	...	
Karachi . .	·623	—·032	—·042	WSW	21	89·0	75	3	...	Strong wind.
Bhuj . .	·622	—·038	—·048	W	18	92·6	47	7	...	
Rajkot . .	·652	—·033	—·01:	WNW	20	93·2	38	6	...	
Surat . .	·716	—·036	—·038	W	19	90·5	56	5	...	
Bombay . .	·751	—·033	—·044	W	15	89·9	66	5	...	Sea slight.
Ratnagiri . .	·803	—·005	+·008	W	...	83·8	75	10	0·69	
Karwar . .	·801	—·008	—·036	NNW	...	85·5	70	6	0·23	Strong wind. Sea very rough.
Mangalore .	·831	—·018	—·023	WNW	4	85·4	76	8	0·03	
Calicut . .	·852	+·011	—·030	N	11	80·7	86	4	0·33	Sea rough.
Cochin . .	·879	+·024	—·014	WNW	3	78·5	89	10	0·60	
Colombo . .	·809	+·031	—·079	W	18	86·5	69	3	...	
Galle . .	·800	+·004	—·078	NW	12	82·5	89	7	...	Strong wind.

TABLE XXX.—*3rd June 1881.*

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				″	°			
S.S. Brinkburn .	1 A.M.		...	...	...	SW	...	Fine weather.
	Noon	17° 30′ N	68° 40′ E	...	...	...	...	Fine weather. Course E by N ½ N. Distance 158 miles.
	Midnight	...	...	...	...	...	...	Showery weather.
S. Canute . .	2 A.M.	...	...	...	...	Variable	...	Heavy showers of rain.
	Noon	4° 33′ N	64° 53′ E	...	...	...	...	Cloudy weather. Swell from SW. Course N 22½° E. Distance 88 miles.
	2 P.M.	...	...	...	...	SW	...	Smart breeze and squally, with heavy rain.
	Midnight	...	...	...	...	WSW	...	Steady breeze and clear weather. High westerly swell.
S. Choice . .	8 A.M.	...	...	...	...	WSW	...	Light steady breeze and fine weather.
	Noon	16° 19′ N	68° 11′ E	29·865	...	WSW	...	Course N 34° E. Distance 168 miles.
	2 P.M.	...	...	...	...	W	...	Fresh steady breeze and fine weather.
S.S. Clan Macleod .	1 A.M.	...	...	...	...	SSW	...	Fresh breeze and cloudy weather with heavy sea.
	5 A.M.	...	...	...	...	SW by W	...	Ditto ditto.
	8 A.M.	...	...	...	...	SW by W	...	Strong breeze and heavy sea.
	Noon	14° 51′ N	55° 20′ E	...	...	SW by W	...	Strong breeze and hazy weather. Course N 73° E. Distance 227 miles.
	1 P.M.	...	...	...	...	WSW	...	Fresh breeze and hazy weather. Ship unable to keep her course.
	7 P.M.	...	...	...	...	...	...	Strong breeze with high sea.
	Midnight	...	...	...	...	...	...	Ditto ditto
S.S. Coniston .	Noon	10° 9′ N	74° 55′ E	...	...	NW	...	Strong wind and heavy cross sea with heavy rain squalls.
S.S. Hartville .	1 A.M.	...	...	...	...	Variable	...	Light breeze and cloudy weather.
	8 A.M.	...	...	...	...	SW	...	Strong breeze and fine weather.
	Noon	13° 16′ N	51° 18′ E	...	...	WSW	...	Strong breeze and increasing southerly sea. Course N 82° E. Distance, 216 miles.
	4 P.M.	...	...	...	...	SW	...	Strong breeze and increasing sea.
	8 P.M.	...	...	...	...	SSW	...	Increasing breeze and slight haze. Increasing sea from southward.
	Midnight	...	...	...	...	SSW	...	Strong breeze and heavy cross sea.
S.S. Mercedes .	1 A.M.	...	...	...	...	WSW	7	Fresh gale and clear sky with a heavy SW sea.
	8 A.M.	...	...	...	...	WSW	6	Strong breeze and clear sky.
	Noon.	17° 26′ N	68° 18′ E	29·782	91·1	WSW	6	Wind and sea the same Course N 75° E. Distance 190 miles.
	8 P.M.	...	...	...	...	W	6	Fine weather.
S.S. Nyanza .	3 A.M.	...	...	29·870	80·3	SW by W	2 to 3	Fine clear weather. Ship rolling heavily.
	7 A.M.	...	...	29·860	84·3	WSW	2 to 3	Ditto ditto.
	11 A.M.	...	...	29·850	88·7	WSW	2 to 3	Ditto ditto.

Name of Vessel.	Hour.	Latitude.	Longitude.	Barometer.	Thermometer.	Wind.		Remarks.
						Direction.	Force.	
				"	°			
S. S. Nyanza —contd.	Noon	15° 32′ N	68° 33′ E	...	...	WSW	2 to 3	Course N 53° E. Distance 260 miles.
	3 P.M.	...	...	29·847	85·3	WSW	2 to 3	Moderate breeze and fine weather. Ship rolling heavily.
	7 P.M.	...	...	29·852	83·3	W	3 to 4	
	11 P.M.	...	...	29·850	80·3	W	3 to 4	
S. Queen's Cliff .	Noon	17° 17′ N	70° 52′ E	...	...	W	...	Fresh breeze and fine weather. Course N 42° E. Distance 161 miles.
S. S. Wistow Hall	1 A.M.	...	...	...	...	SW	...	Fresh breeze and hazy weather with showers of rain.
	Noon	19° 9′ N	68° 35′ E	29·709	85·2	WSW	...	Fresh breeze. Course N82°E. Distance 267 miles.
	1 P.M.	...	...	...	...	SW	...	Moderate breeze and hazy weather with a SW swell.

CHAPTER III.

Summary and Discussion of Results.

In order to bring into one view the gradual growth and decay of the cyclone from day to day, its track, and the rate of motion of the centre along that track, the principal facts relating to these points are grouped together in the following table:—

Table XXXI.

Date.	North Latitude at noon	East Longitude at noon	Movement in preceding 24 hours	Rate of movement per hour	Direction of movement	Lowest observed pressure.	Corresponding distance from Centre of cyclone.	Corresponding abnormal pressure.	Corresponding force of wind.	Diameter of isobar of 29·5.	Force of monsoon wind outside Isobar of 29·7.
	of Centre of cyclone,										
1881			Miles.	Miles.		Inches.	Miles.	Inches.	Beaufort's Scale.	Miles.	Beaufort's Scale.
26th May .	13° 48′	66° 56′	...	...	...	29·69	71	—0·16	9	0	4·4
27th „ .	13° 48′	66° 56′	0	0	...	29·50	44	—0·35	10	90	4·7
28th „ .	15° 9′	67° 28′	102	4·2	N 21° E	28·80	12	—1·03	12	150	5·2
29th „ .	16° 40′	66° 14′	132	5·5	N 37° W	27·15	0	—2·69	0	300	5·6
30th „ .	18° 36′	63° 45′	208	8·7	N 51° W	29·20	90	—0·63	11	370	5·7
31st „ .	19° 20′	61° 32′	152	6·3	N 71° W	29·06	80	—0·77	12	440	4·8
1st June .	19° 50′	60° 15′	90	3·7	N 67° W	29·35	110	—0·48	10	330	3·2
2nd „ .	20° 33′	58° 52′	100	4·2	N 61° W	29·49	180	—0·32	8	330	4·1

The track is represented in Plate XXXV. The beginning of the track is the point marked May 27th. At this spot the cyclone originated between the 25th and 27th. The circle drawn round this point as a centre represents the isobar of 29·5, and indicates the area of that portion of the storm field within which the winds blew with great violence. Between noon of the 27th and noon of the 28th the storm moved in a NNE direction, at an average rate of 4·2 miles per hour, to the position indicated by the point marked May 28th, and its area increased very much, as shown by the circle drawn round this point. Between the 28th and 29th the cyclone moved in a NW by N direction, at the somewhat greater average rate of 5·5 miles per hour, and still further increased in area. Be-

tween the 29th and 30th it moved towards the NW at the still greater rate of 8·7 miles per hour, and continued to increase in area. Between the 30th and 31st it moved less rapidly in a WNW direction, at the rate of 6·3 miles per hour, and apparently increased still more, but of this there is some doubt. During the next two days it continued to move in a west-north-west direction at the slower rates of 3·7 and 4·2 miles per hour respectively, and it probably gradually contracted in area after the 31st. The last column of the table shows that the strength of the monsoon winds, outside the isobar of 29·7 and outside the storm field proper, gradually increased from the 26th to the 30th, and thereafter decreased, thus running a course almost parallel to that indicated by the increase and decrease of the area of the cyclone proper. The gradual increase and decrease of the rate of motion of the centre of the cyclone also runs a course nearly parallel to that indicated by the growth and decadence of the monsoon winds. This is probably more than a mere coincidence, as will presently be seen.

In order to determine the average characteristics of the cyclone, the amount of incurvature of the winds in different octants, the relation between the barometric gradients and the force of the winds, &c., and in order to provide the means of comparing the observations with theory, the data shown in the following table have been extracted from the rough charts on which the noon observations were first entered. The headings of the several columns suffice to show the nature of the entries contained in them. The angles between the radius of the cyclone and the wind were measured from the charts with a protractor, and the gradients were determined by first measuring the distance apart from the two nearest isobars with a scale of nautical miles, and afterwards converting the distances into differences of pressure per 60 nautical miles. The barometric pressures entered in column 10 are the pressures read from the storm charts. The normal pressures of column 11 were obtained by interpolation from Mr Dallas's pressure charts of the Arabian Sea for May and June. The abnormal pressures entered in column 12 are the differences between the numbers of columns 10 and 11. Only the noon observations of such ships as happened to lie inside the closed isobars have been entered in this table—

TABLE XXXII.

Date	Latitude of Ship (Noon)	Longitude of Ship (Noon)	Wind: Direction	Wind: Force	Distance from Centre of Cyclone	Quarter of Cyclone	Angle between Wind and Radius	Barometric Gradient per Nautical Mile	Barometric Pressure	Normal Barometric Pressure	Abnormal
1881.					miles				Inches.	Inches.	Inch.
26th May . .	13° 5′	65° 45′	NW	7	71	W	34°	...	29·63	29·85	—·16
27th May . .	13° 42′	66° 15′	NW	5	41	W	46°	·120	·50	·85	—·35
" " . .	13° 22′	65° 19′	LNE	7	115	N	53°	·113	·62	·84	—·22
" " . .	16° 2′	66° 55′	NE	5	160	N	45°	·085	·67	·83	—·16
28th May . .	12° 20′	65° 22′	W	11	25	S	93°	·300	·30	·83	—·53
" " . .	15° 7′	66° 50′	NNW	10	50	NW	38°	·300	·44	·81	—·40
" " . .	13° 35′	66° 4′	W	7	116	SW	65°	·143	·59	·84	—·25
" " . .	13° 41′	65° 52′	E	9	137	N	84°	·185	·62	·81	—·19
" " . .	13° 42′	65° 50′	NE	8	213	NW	75°	·067	·68	·82	—·14

Date.	Latitude of Ship (North).	Longitude of Ship (East).	Wind.		Distance from centre of Cyclone.	Octant of Cyclone.	Angle between Radius and Wind.	Barometric Gradient.			
			Direction.	Force.				....s.			
1881				Miles.					Inches.	Inches.	Inch.
29th May . .	16° 52′	65° 50′	NE	12	35	NW	92°	1·500	28·70	·84	—1·14
,, ,, . .	15° 43′	67° 15′	SW	10	95	SE	90°	·333	29·34	·83	—·49
,, ,, . .	15° 15′	66° 22′	WSW	10	100	S	71°	·333	·37	·85	—·48
,, ,, . .	17° 40′	64° 11′	*NNE	9	150	NW	84°	·091	·50	·85	—·35
,, ,, . .	16° 46′	63° 53′	WNW	9	155	W	20°	·091	·51	·83	—·32
,, ,, . .	18° 18′	67° 48′	SE	10	157	NE	92°	·085	·52	·80	—·28
,, ,, . .	18° 5′	64° 16′	ENE	7	163	NW	119°	·088	·53	·82	—·29
,, ,, . .	13° 28′	67° 2′	SW	7	224	S	57°	·085	·60	·85	—·25
30th May . .	17° 14′	62° 50′	SW	9	112	SW	12°	·100	·40	·84	—·44
,, ,, . .	18° 3′	61° 46′	WNW	9	138	W	36°	·105	·43	·83	—·40
,, ,, . .	16° 59′	61° 48′	W	6	170	W	40°	·100	·48	·84	—·36
,, ,, . .	17° 50′	66° 10′	SSE	6	178	E	53°	·085	·50	·82	—·32
,, ,, . .	15° 50′	64° 3′	SSW	11	185	S	52°	·085	·51	·85	—·34
,, ,, . .	15° 50′	65° 16′	WSW	7	215	SE	95°	·085	·54	·85	—·31
31st May . .	16° 29′	61° 29′	SW	12	68	S	37°	·300	·00	·85	—·85
,, ,, . .	17° 10′	63° 15′	SW	6	190	SE	81°	·120	·41	·84	—·40
,, ,, . .	16° 15′	61° 50′	SW	9	210	S	50°	·120	·47	·85	—·38
,, ,, . .	16° 19′	60° 54′	SW	7	215	S	33°	·120	·48	·84	—·36
,, ,, . .	16° 11′	63° 3′	SW	6	245	SE	68°	·080	·53	·85	—·32
,, ,, . .	18° 3′	65° 30′	SSW	5	280	E	95°	·077	·57	·81	—·24
,, ,, . .	15° 42′	63° 57′	SSW	9	298	SE	78°	·075	·58	·83	—·25
1st June . .	17° 47′	61° 29′	SW	9	170	SE	74°	·067	·50	·83	—·33
,, ,, . .	16° 52′	60° 8′	SW	10	213	S	44°	·075	·56	·83	—·27
,, ,, . .	17° 2′	63° 32′	S	9	268	S	1°	·072	·59	·84	—·25
,, ,, . .	16° 0′	60° 21′	SW	6	300	SE	92°	·050	·60	·84	—·24
2nd June . .	18° 15′	60° 34′	SSW	7	200	SE	56°	·071	·53	·81	—·28

For the purpose of calculating average values of the gradient, of the angle between the radius of the cyclone and the wind, of the distance of the ship from the cyclone centre, of the barometric pressure, of the abnormal pressure and of the force of the wind, the data in the above table have been classified in three different ways; 1st, in accordance with the gradient; 2nd, in accordance with the distance from the centre; and, 3rd, in accordance with the octant of the cyclone; certain arbitrary limits of gradient and of distance having been selected to form the boundary of each class. The results are shown in the following table.

* In the subsequent calculations NNW was used by mistake for this observation of NNE. The results will be but slightly affected by this error.

TABLE XXXIII.—*Average values of certain Cyclone Elements.*

	Classified with respect to the Gradient.				Classified with respect to the distance from the centre of the cyclone.					Classified with respect to the Octant of the cyclone.							
	Limits of Gradient in inches.				Limits of distance from centre in miles.					Octant of Cyclone.							
Limits	·050 to ·099	·100 to ·149	·300 to ·399	1·500	0 to 49	50 to 99	100 to 149	150 to 199	200 to 300	N	NE	E	SE	S	SW	W	NW
Gradient in inches	·079	·115	·306	1·500	·640	·311	·147	·090	·081	·091	·085	·081	·110	·166	·121	·104	·136
Angle between radius and wind in degrees.	65°	46°	66°	92°	77°	51°	53°	61°	62°	61°	92°	74°	79°	49°	37°	36°	68°
Distance from centre in miles	206	146	68	35	35	71	120	163	240	137	157	229	214	168	115	108	144
Pressure in inches	29·560	29·490	29·290	28·700	29·167	29·367	29·505	29·516	29·561	29·637	29·520	29·535	29·507	29·431	29·495	29·522	29·537
Abnormal pressure in inches	—·270	—·351	—·550	—1·140	—·673	—·475	—·330	—·315	—·274	—·190	—·280	—·280	—·327	—·412	—·345	—·318	—·295
Force observed, Beaufort's scale	7·8	7·6	10·3	12·0	10·1	9·7	8·5	6·8	7·5	7·0	10·0	5·5	7·5	9·6	8·0	7·8	8·5
Force calculated	7·1	7·6	8·9	12·0	10·1	9·5	8·1	7·1	7·4	6·6	7·2	7·5	8·6	9·4	7·1	6·4	8·4
Velocity observed in miles	46	45	68	90	66	62	52	39	44	40	65	31	44	61	48	47	52
Velocity calculated in miles	41	45	59	102	66	60	49	41	43	38	42	44	53	59	41	36	51
Number of observations	19	9	5	1	3	4	6	10	12	3	1	2	8	9	2	5	4

The forces, according to Beaufort's scale, in the sixth line of the table have been converted into the velocities, in miles per hour, in the eighth line, by means of the following table, which rests on the authority of the British Meteorological Council :—

TABLE XXXIV.

Beaufort's scale.		Corresponding velocity of wind in miles per hour.
0	Calm	3
1	Light air	8
2	Light breeze	13
3	Gentle breeze	18
4	Moderate breeze	23
5	Fresh breeze	28
6	Strong breeze	34
7	Moderate gale	40
8	Fresh gale	48
9	Strong gale	56
10	Whole gale	65
11	Storm	75
12	Hurricane	90

The calculated forces and velocities in the seventh and ninth lines of table XXXIII will be explained hereafter.

The average results of all the observations except one, which cannot appropriately be combined with the rest, because of the very excessive steepness of the gradient, are as follow :—

Mean barometric gradient in inches per 60 nautical miles	·123
,, angle between radius and wind	60°
,, distance from centre of cyclone in miles	169
,, pressure in inches	29·500
,, abnormal pressure in inches	—·335
,, force of the wind (Beaufort's scale)	8·2
Corresponding mean velocity of the wind in miles per hour	50

The averages obtained by arranging the observations in accordance with the gradient, and with distance from the centre, show a tolerably regular increase of gradient and force with decrease of distance from the centre, but they show no such regular increase of the angle between the radius and the wind as the distance from the centre decreases. No doubt this angle is greater near the centre than farther away from it, but the observations are too few to give averages showing a regular progression. From the results obtained by arranging the observations in accordance with distance from the centre, it appears that an increase of distance from 120 to 168 miles corresponds to a decrease of ·057″ in the gradient, and to a decrease of 1·7 in force. With these rates of change the gradients and forces obtained by arranging the observations in accordance with the octant of the

cyclone have been reduced to what they would become at a uniform distance of 150 miles from the centre; but as no satisfactory rate of change of the angle with change of distance from the centre can be directly determined from the observations, the angles are left unaltered. The results are shown below—

TABLE XXXV.

Octant.	Gradient.	Distance from centre.	Force on Beaufort's scale.	Corresponding velocity in miles per hour.	Angle between radius and wind.
	Inch.	Miles.			
N	·076	150	6·5	37	61°
NE	·093	150	10·2	67	92°
E	·175	150	8·3	50	74°
SE	·186	150	9·8	63	79°
S	·187	150	10·2	67	49°
SW	·079	150	6·8	39	37°
W	·054	150	6·3	36	36°
NW	·129	150	8·3	50	68°

The results given in the last two columns of this table are graphically represented by Fig. 1, Plate XXXVI, on a scale of 60 miles to an inch. The arrows are drawn so as to fly with the wind, and their lengths are proportional to the velocity. It will be at once seen by an inspection of this diagram that, although, looking from the centre, the winds in each octant of the cyclone turn towards the left hand and generally inwards towards the centre, they do not make equal angles with the radius of the cyclone in all the octants; in other words, although, standing with the back to the wind, the centre is always on the left hand, its bearing is very different in different octants of the cyclone, being about 4 points in the west, south-west, and south octants; about 6 points in the north and north-west octants; about 7 points in the south-east and east octants, and about 8 points in the north-east octant. Another important deviation from perfect symmetry is that the winds in the north-east, east, south-east, and south octants are much stronger than those in the south-west, west, north-west and north octants. Now, although some departure from true symmetry is what might be expected to result from real irregularities in different parts of the cyclone and from roughness of the observations, yet there is too much that is systematic in the peculiarities above mentioned, to render it at all probable that they can be attributed to these causes alone. And besides, a departure from symmetry of the kind shown by the figure, is almost exactly what would result from the combination of a moderate south-westerly monsoon wind with a symmetrical cyclone wind; a combination, which, judging from the intimate relation between the cyclone wind and the monsoon wind shown by the results of table XXXI, is in itself very probable. Adopting this view, it becomes possible to calculate, from the observed winds of the cyclone, two mean component parts, *viz.*, a progressive monsoon wind, and a symmetrical cyclone wind, which, when combined, shall produce resultant winds in near agreement with the actual winds of the cyclone. If the actual winds of the eight octants of the cyclone be resolved into their north and east components, and the averages of these be taken, the results will be the

north and east components of the monsoon wind, because the symmetrical parts of the cyclone winds will cancel each other, there being as much north wind as south wind, and as much east wind as west wind in a symmetrical cyclone. The north and east components of the winds corresponding to the data in the last two columns of table XXXV are given in the first and second lines of the following table:—

TABLE XXXVI.

Octant of Cyclone.	N	NE	E	SE	S	SW	W	NW	Mean.
North component of actual wind .	+17·9	−49·0	−48·0	−52·2	−44·0	−6·1	+21·2	+46·0	−14·3
East " " " " .	+33·4	+45·7	+13·8	−35·2	−50·6	−38·5	−29·1	+19·5	−5·2
North " " cyclone " .	+32·2	−34·7	−33·7	−37·9	−29·7	+8·2	+35·5	+60·3	
East " " " " .	+37·6	+50·9	+19·0	−30·0	−45·4	−33·3	−23·9	+24·9	
Radial " " " " .	+32·2	+11·5	+19·0	+5·6	+29·7	+17·7	+23·9	+25·0	+20·6
Tangential " " " " .	+37·6	+59·5	+33·7	+48·0	+45·4	+29·3	+35·5	+60·2	+43·4
North " " mean cyclone " .	+20·6	−16·1	−43·3	−45·2	−20·6	+16·1	+43·3	+45·2	
East " " " " " .	+43·3	+45·2	+20·6	−16·1	−43·3	−45·2	−20·6	+16·1	
North " " " " " and mean monsoon wind combined.	+6·3	−30·4	−57·6	−59·5	−34·9	+1·8	+29·0	+30·9	
East component of mean cyclone wind and mean monsoon wind combined.	+38·1	+40·0	+15·4	−21·3	−48·5	−50·4	−25·8	+10·9	
Corresponding resultant velocity . .	38·6	50·2	59·6	63·2	59·7.	50·4	38·8	32·8	
" " direction . .	N 81° E	S 53° E	S 15° E	S 20° W	S 54° W	N 88° W	N 42° W	N 20° E	
" angle between radius and wind.	81°	82°	75°	65°	54°	47°	48°	64°	
" barometric gradient calculated by Ferrel's formula.	·080	·121	·162	·179	·162	·122	·081	·063	·121
Observed barometric gradient, from table XXXV.	·076	·093	·175	·186	·187	·079	·054	·129	·122

The average north and east components are given in the last column. These are equivalent to a resultant monsoon wind of 15·3 miles per hour, from the direction S 21° W. The subtraction of the mean north component from each of the numbers in the first line of the table gives the numbers in the third line; and the subtraction of the mean east component from the numbers in the second line gives those in the fourth line. These two lines of numbers represent the wind that is left after eliminating the mean monsoon wind. They therefore include the symmetrical portions of the cyclone proper, and all the irregularities of the original observations. In the fifth and sixth lines of the table the north and east components given in the third and fourth lines are converted into radial and tangential components, and in the last column, the means are taken. These are, a mean radial component of 20·6 miles per hour, and a mean tangential component of 43·4 miles per hour, which are equivalent to a resultant wind of 48·0 miles per hour in a direction inclined to the radius at an angle of 64° 37′. In the seventh and eighth lines of the table the equivalent north and east components of this mean cyclone wind are given for each octant of the cyclone; and by adding respectively to these values the north and east components of the mean monsoon wind, the numbers in the ninth and tenth lines of the table are obtained; and these, converted into their equivalent resultant winds give the results in the 11th and 12th lines. In the 13th line the angles included between these winds and the radius are given; and, finally, the results of the last three lines are graphically represented by

figure 2, plate XXXVI, for comparison with figure 1, which is drawn from the actual observations. Figure 2, it will be observed, is obtained by a simple combination of a mean cyclone wind with a mean monsoon wind. It differs from figure 1 only to such an extent as might be expected from the irregularities in the observations, which are all included in figure 1, but all excluded from figure 2, by the method of calculation. The latter therefore represents the general characteristics of the cyclone better than the former, and affords a very complete and simple explanation of the absence of symmetry in the actual observed winds of the cyclone; showing that the differences on the different sides are due to the superposition on the cyclone wind of a monsoon wind which inclines the cyclone winds on the south-west side more towards the centre, but inclines those on the opposite or north-east side farther away from the centre; while it strengthens the cyclone winds on the south-east side by combining with them, and weakens those on the north-west side by opposing them without much changing their directions. The importance of these results to the navigator can hardly be overestimated. They will be reverted to hereafter when considering the general subject of cyclone indications.

Figure 2 shows that the centre of the cyclone is not the central point round which the winds at a distance of 150 miles from the centre are circulating. It happens that the wind in the north-west and south-east octants are nearly equally inclined at an angle of $64\frac{1}{2}^\circ$ to their respective radii, but the inclination of the wind in the north-east octant to its radius is $17\frac{1}{2}^\circ$ greater than this, and the inclination of the wind in the south-west octant to its radius is $17\frac{1}{2}^\circ$ less. A new central point may, however, be chosen, to the north-west of the real centre, and at such a distance from it that new radii drawn therefrom to the middle points of the wind arrows in the north-east and south-west octants shall make equal angles of $64\frac{1}{2}^\circ$ with those winds, and that new radii drawn from the new centre to the middle points of the wind arrows in the north-west and south-east octants shall have their inclinations the same as before. New radii drawn from this new central point to the middle of each of the wind arrows in the north, east, south and west octants respectively, will then make equal angles of $64\frac{1}{2}^\circ$ with each of those winds. As the winds in all the octants will then make equal angles with their respective new radii drawn towards the new centre, they may with more propriety be regarded as rotating round this new centre rather than round the centre about which the winds in the interior of the cyclone rotate; that is to say, the winds in the outer part of the cyclone, and those in the inner, may be regarded as rotating round different centres, the position of the new centre being towards the north-west of the old one.

A rigid geometrical method of finding the position of the new centre in a hypothetical case is shown by figure 3, Plate XXXVII, which is drawn to a scale of 60 miles to an inch. The radius Ac is taken at 150 miles, the lines Ac in the several octants represent symmetrical cyclone winds of 50 miles per hour, each inclined at a uniform angle of 65° to its radius. The lines cb represent superposed south-west monsoon winds of 20 miles per hour, and the thick lines Ab represent the respective unsymmetrical resultants of the symmetrical cyclone wind and the monsoon wind. On the radius AC, say the one pointing to the south-west, and on the north-west side of it, construct a triangle ACB similar to the triangle of forces at the outer end of AC, making the angle BAC equal to the angle bAc, and the angle ACB equal to the angle Acb, and join the point B with dotted lines

to each of the eight points A on the circumference of the circle, thus forming with the radii of the circle and the line CB the system of eight triangles ABC, each of which is, as a little consideration will show, similar to the triangle of forces drawn at the outer end of its own base, the radius AC. Each of the triangles of this system may be conceived as having been formed by rotating its triangle of forces 65° in a left handed direction, round the point A, when Ac will coincide with AC; and then, keeping the point A fixed, magnifying the triangle until c coincides with C, when b will coincide with B. The following conclusions may easily be deduced from this construction. First, each of the lines Ab is inclined to its new radius AB at an angle of 65°, which is the same angle as that which the symmetrical cyclone wind Ac makes with its radius AC. Second, the ratio of any resultant wind Ab to its new radius AB is constant, that is, $\frac{r}{R} = \frac{r'}{R'}$, r being a resultant wind and R its new radius, and the accented letters being used to indicate any other resultant wind and its new radius; and therefore third, the angular velocity round the new centre B is constant, that is, $\frac{r \sin 65°}{R} = \frac{r' \sin 65°}{R'}$; and fourth, the radial component of the velocity along the new radius AB is proportional to AB, that is $\frac{r \cos 65°}{R} = \frac{r' \cos 65°}{R'}$; in other words, particles starting at the same time from the outer ends of the new radii, and continuing to move along them with their initial radial velocities would all arrive at the new centre B at the same time; fifth, the line CB is inclined to the left of the monsoon wind cb at an angle of 65°, and it is directed from the point on the circumference of the circle where the resultant velocity is a maximum, to the point where it is a minimum, that is, from the point where the directions of the ymme trical cyclone wind and of the monsoon wind coincide, to the point where they are directly opposed to each other. Now, these conclusions seem to render it at least probable that in an unsymmetrical cyclone of the kind represented by figure 3, the winds in the outer parts will, as they move inwards, form a new centre at B, instead of continuing to reproduce a centre at C, and if so, the line CB will represent the path of the cyclone. Applying these principles to the cyclone under discussion as represented by figure 2, it appears that, since the direction of the monsoon wind was S 21° W, and the angle between the symmetrical cyclone wind and the radius was 65°, the mean path should have been in the direction N 44° W. The direction of the line joining the position where the storm originated on the 27th May to that which the centre occupied on the 2nd June is N 50° W, which agrees pretty closely with the estimated direction. The change in the direction of the path from day to day seems also to be explained by these principles. In the position where the cyclone originated the normal monsoon wind is nearly due west, and a westerly wind, combining with the cyclone wind, would cause the centre to move NNE. Farther to the northward, the normal monsoon wind comes from WSW and SW, and, accordingly, the direction of the track should here be first towards the north, and afterwards towards the north-north-west. Farther to the north-west and west, the normal monsoon wind gradually becomes more southerly, until on the coast of Arabia it is probably nearly due south, and this gradual backing of the monsoon wind should cause the path of the cyclone in these regions to change gradually from north-north-west to west-north-west. The actual motion of the cyclone, as shown by the track chart, is in general agreement with these requirements, the path having first been towards the north-north-east, and afterwards having gradually curved round by north to west-north-west, always maintaining a course about six points to the left of the normal monsoon wind of the region through which it passed.

In the fourteenth line of table XXXVI the calculated barometric gradients corresponding to the wind velocities and angles in the eleventh and thirteenth lines are given. These gradients are obtained from Ferrel's formula, which, for the latitude and mean temperature of Bombay, *viz.* 18° 54′ N and 79°8 Fahr. respectively, and neglecting the small effect due of change of pressure, reduces to—

$$G = \cdot 000809 \text{ (cosec. } \alpha) \, s + \cdot 00476 \, \frac{s^2}{r}$$

where G is the gradient in inches of mercury per 60 nautical miles, α is the angle between the radius of the cyclone and the direction towards which the wind is moving, r is the radius in miles, and s is the velocity of the wind in miles per hour. To adapt the above formula to the mean latitude of the cyclone, which, by weighting the individual daily determinations in proportion to the number of observations for that day in table XXXII, comes out 17° 25′ N, the first term should be multiplied by $\frac{\sin 17° 25'}{\sin 18° 54'} = \cdot 924$, which practically is equivalent to a reduction of eight per cent. This reduction has been made. Since the factor (cosec. α) in the first term of Ferrel's formula for the gradient depends theoretically on friction, and there is no reason to suppose that in the open ocean the friction co-efficient can differ largely on different sides of the cyclone, there seems some doubt about the propriety of using the different values of α in the different octants for calculating the factor (cosec. α). The mean value 65° has therefore been used.

In the last line of table XXXVI, the average observed gradients in each octant, corrected to the uniform distance of 150 miles from the centre, are entered for comparison with the calculated values. The mean of all the calculated results is ·121, which is almost identical with the mean of the observed values, *viz.* ·122. There are considerable discrepancies between the calculated and observed results for one or two of the octants, which is to be expected in rough observations of this kind, but there is, notwithstanding, a very general agreement in most of the octants, and the mean calculated result for the E, SE, S, and SW octants, in which the wind velocity is above the average, agrees well with the mean observed value, the two being ·156 and ·157 respectively. So also for the WNW, N, and NE octants, in which the wind velocity is below the average, the mean calculated value, ·086, is very close to the mean observed value, ·088. Too much importance must not, however, be attached to this very near agreement, for, while, on the one hand the process of calculating average gradients at average distances from the centre tends to make the gradients thus obtained from observation somewhat too high, and so to produce some disagreement between the observed and calculated results; on the other hand, there is reason to believe that the scale for converting wind forces into miles, somewhat exaggerates the wind velocities and unduly increases the calculated gradients, thereby tending to restore agreement between the calculated and observed results. Only in case these two tendencies should happen to produce equal effects on the calculated and observed gradients, could it be said that the formula perfectly represents the observations. The most important result is that both the calculated and the observed gradients are very much steeper on the south-east side of the cyclone than on the north-west side. Indeed in the south-east octant, they are three times as steep as in the north-west octant. The isobars must therefore be much closer together on the south-east side than on the north-west, and it is clear that a system of concentric circles drawn round the centre of the cyclone will not truly represent them. A system of similar and similarly placed confocal ellipses with their major axes extending from south-east to north-west, and with the centre

of the cyclone in the common focus would probably best represent a system of isobars, that would be in best general agreement with the observed mean gradients. Such a system of isobars would tend to equalize the angles of inclination of the wind to the isobars in the different octants of the cyclone.

Ferrel's formula has also been employed to calculate each of the wind velocities entered in the ninth line of table XXXIII from the gradient, angle, and distance in the preceding lines of the same column. For this purpose the formula for the latitude of Bombay was used, but as the mean latitude of the cyclone was more than a degree lower, some of the smaller calculated velocities may, on this account, be as much as two or three miles too small. The high velocities, however, will be scarcely affected by this circumstance. The numbers in the seventh line are the corresponding calculated forces according to Beaufort's scale, the conversions having been made by means of table XXXIV. All that need be said about these results is that, on the whole, they are in very fair agreement with the observed velocities. This conclusion is a very valuable one, because it proves that the formula may be safely used as a guide in estimating the probabilities of rough weather on the western coast of India.

In order to determine the direction of the line joining the point on the circumference of the cyclone where the gradient is greatest to the point where it is least, the constants of the first periodical term of Bessel's formula $X=M+U' \sin (n\,45°+u')+$&c., have been calculated from the observed values of the gradient in table XXXV, the angles being reckoned from north round by east, and n representing the number of the octant. The results are $U'=·055$; $u'=320°$, from the last of which it appears that the maximum value of the periodical term occurs in the azimuth S 50°E, the minimum value at N 50°W. The latter is exactly the direction of the path of the centre of the cyclone from the point where it originated, to the point where it was last observed, so that, independently of any theoretical views, the observed fact is, that the cyclone moved from the direction of the steepest gradient to the direction of the weakest gradient.

A similar statement may be made respecting the winds and the cyclone path, *viz.* that, as an observational fact, the cyclone moved from that side of the storm circle where the wind was strongest to that side where it was weakest. These statements of fact are in perfect harmony with the conclusions drawn from figure 3, for the path of the cyclone is there shown to be in the line joining the strongest wind on one side of the cyclone to the weakest on the other, the motion being from the former to the latter; and, as in cyclones, the strongest wind is always associated with the steepest gradient, this line is also the line joining the steepest gradients on one side of the storm circle to the weakest on the other.

A similar conclusion has already been arrived at by Mr. Eliot respecting the cyclones of the Bay of Bengal. In his paper on the south-west monsoon storm of the 8th to the 19th October 1882, published in the Indian Meteorological Memoirs, Vol. II, page 155, he says, "In the case of cyclones of the transition periods, an examination of those of recent occurrence, seems to show that they advance in the direction of relative least air motion, immediately prior to the generation and motion of the vortex." Figure 3 appears to afford a satisfactory explanation of this inference from observation, for it shows that the direction of motion of the cyclone is such that the first effect of its approach is to neutralize the normal wind, and so to cause less than the normal amount of air motion. It also explains

why very violent storms are usually preceded by calms, and why, after the passage of the centre when the wind suddenly changes to the opposite direction, the storm bursts forth again with greater violence than before.

Vertical thickness of the cyclone.—It has already been mentioned that one of the vessels involved in the cyclone reported the occurrence of hail on two different occasions, once at midnight on the 29th May, and again at 8 A.M. on the 30th May. At the latter hour the vessel was probably about 100 miles to the south-west of the centre, and probably at this time the storm had almost reached its maximum intensity. It is known that in the inner parts of a cyclone, the air rises upwards and flows outwards in the upper regions of the atmosphere. This follows immediately from the observed fact that, although air is pouring into the central part from all round the circumference, the pressure in the centre remains low. It is this rapid rising, and consequent cooling, of the damp air which causes the rapid condensation of vapour, and produces the heavy rainfall observed in the central portions of the cyclone. It is also known that saturated air, at an initial temperature of 80° Fahr., cools, as it ascends, at a mean rate of about ·22 of a degree Fahrenheit for every 100 feet of ascent, and as hail could not be formed until the air had cooled down to the freezing point, that is to 32°, or 48° below the initial temperature, the air must have risen about 22,000 feet before the hail was formed. It probably rose very much higher than this. The vertical thickness of the cyclone must therefore have been at least 22,000 feet.

Barometric curves.—All the more important barometric curves are drawn in Plate XXXVIII. These are given to show the navigator what kind of barometric movements he may expect his instrument to make when his ship is in the immediate neighbourhood of a violent cyclone in the Arabian Sea. The arrows marked along the course of the curves show the direction of the wind and its force according to Beaufort's scale. A separate barometer scale for each curve is marked on the left of each figure. The curves are of very different shapes, although all are obtained from observations made in the same cyclone, the differences being mainly due to the different paths taken through the storm field by the different vessels. Those showing the biggest depressions are of course given by the ships which passed nearest the centre, and the lack of symmetry on the falling and rising sides of the same curve is attributable, partly to the different rates at which the vessels entered and left the storm field, and partly to a real difference in the barometric features of the south-eastern and north-western sides of the cyclone. Figures A_1, A_2, and A_3 are given by the observations of three sailing vessels that were making the outward voyage round the Cape to Bombay; figures B_1, B_2, and B_3 by those of three steamers going from Aden to Bombay, and figures C_1, C_2, and C_3 by those of three homeward bound steamers from Bombay *viâ* Suez. In one or two cases the curve is dotted, to indicate that the observations appear doubtful. Figures B_1, C_1, and C_2 confirm each other in showing that the gradients on the eastern side of the cyclone were much steeper than on the western side, in accordance with the result already deduced from the averages of all the available noon observations entered on the charts.

Means of avoiding the dangerous winds of a cyclone in the Arabian Sea.—A careful study of these curves, and their comparison with figure 2, will perhaps best show how the most dangerous winds in the inner parts of a cyclone in the Arabian Sea in the months of May or June may be avoided. It appears from the barometric curves and the ships' logs

that most of the ships succeeded in avoiding the centre by performing suitable manœuvres; but it also appears that many of them passed so far into the storm field as to become involved in the violent winds circulating round the centre; and it is evident that, if the dangerous winds are to be avoided, steps should be taken for this purpose much sooner than seems to be the usual practice. It does not appear to be generally known to navigators that, in the Arabian Sea, a fall of the barometer down to three-tenths of an inch below the normal pressure of the season is a certain indication of the existence of a cyclone. A fall to only two-tenths of an inch below the normal is but a rare occurrence, and it is almost invariably accompanied by unsettled cyclonic weather, while a fall to three tenths of an inch below the average pressure of the time of day and season of the year, is a sure indication of the formation of a decided cyclone. Of course, if the pressure nowhere falls lower than this, the cyclone is but a small one, though of its existence there can be no doubt. The probability is, however, that in most cases, the pressure will be still lower not very far away. At the time when the pressure has fallen to ·3″ below the normal, the wind in the north-east and south-west quadrants of the cyclone will probably have risen to a moderate or a fresh gale, but in the north-west quadrant, that towards which the whole of the storm field is probably advancing, and therefore the most dangerous one, the wind will probably have risen only to a fresh breeze, while in the south-west quadrant it will probably be blowing with the force of a strong gale. This is the time at which the propriety of changing the course of the vessel should be most carefully considered. To continue much longer on the same course would most likely be fraught with the greatest danger, whereas a judicious deviation to the right or left, according to circumstances, would, in most cases, carry the vessel in a few hours to a safe distance from the centre. The first thing to be determined is the bearing of the centre. Figure 2 shows that no uniform rule for finding this bearing is always applicable to all the octants of a cyclone in the Arabian Sea; and when the barometer has fallen about ·3″ below the normal, the rule of 10 points to the right, when facing the wind, or 6 points to the left, when standing with the back to the wind, may be about 2 points in error one way or the other. Instead of using this rule it would be better to estimate the direction of the centre by consulting figure 2, which shows how the bearing of the centre from the wind direction varied in the different octants of the cyclone of May and June 1881.

A still better estimate may be made by means of the following construction:—

1st—Draw an arrow (No. 1) to represent, as in figures 4 and 5, Plate XXXVII the actual wind which is blowing at the time of observation, the length being made proportional to the force or the velocity of the wind, and the barb being drawn to represent the arrow flying with the wind.

2nd—Draw another arrow (No. 2) to represent the normal monsoon wind of the time and place. No. 2 must be drawn with its head or point touching the head of No. 1.

3rd—Draw a third arrow (No. 3) from the tail of No. 1 to the tail of No. 2 with its head or barbed end on the tail of No. 2. Arrow No. 3 will represent the symmetrical cyclone wind uninfluenced by the monsoon wind.

4th—Draw a line inclined to arrow No. 3 at an angle of 65° to the left looking from the tail towards the head of the arrow No. 3. This line will point to the centre of the cyclone.

The above construction eliminates the influence of the monsoon wind upon the bearing of the centre. It is applicable to all the octants of the cyclone, and to the time when the barometer has fallen to about ·32″ below the normal, and the symmetrical cyclone wind has risen to about 48 miles per hour or to force 8 on Beaufort's scale. If the barometer has fallen more than this, and the cyclone wind has risen to a greater force than 8, the bearing of the centre will be more than 65° to the left of the direction towards which the cyclone wind is moving. Ferrel has given the following formula for finding approximately the bearing of the centre in a symmetrical cyclone, that is, the angle (α) between the radius of the cyclone and the direction towards which the symmetrical cyclone wind is blowing—

$$\text{Cotan. } \alpha = \frac{f}{\cdot 505 \text{ Sin } \theta + \frac{s \text{ Sin } \alpha}{r}}$$

where s is the velocity of the wind in miles per hour, θ is the latitude, f is a factor depending on friction, and r is the distance from the centre of the cyclone. Inserting in this formula the values $\alpha = 64° 37'$; $\theta = 17° 25'$; s = 48 miles; and r = 150 miles, which are the average results obtained on a previous page for the cyclone under discussion, the value of f comes out ·212, and by using this value of f the following values of α are obtained, corresponding to certain average observed values of r and s taken from table XXXIII—

TABLE XXXVII.

Bearing of centre.	Distance of centre.	Wind velocity.	Corresponding wind force on Beaufort's scale.	Corresponding average abnormal depression of barometer.
α	r	s		
	Miles.	Miles.		Inch.
56	240	44	7·4	0·274
65	150	48	8·0	0·321
74	100	56	9·0	0·388
81	55	65	10·0	0·560
86	35	90	12·0	1·140

In the last two columns of the above table the observed force of the wind and the average abnormal depression of the barometer corresponding to the calculated bearing of the centre in the first column are given from table XXXIII. From table XXXVII a good estimate can be made of the most probable bearing of the centre of the cyclone for use in the construction just described.

The only practical difficulty in this construction is the determination of the normal monsoon wind of the time and place. Unfortunately, no charts, giving this information directly, have ever been published, but a rough estimate might be made from the wind charts of the Arabian Sea, published by the Indian Meteorological Department, or, for the present, the average monsoon wind found to have been combined with the cyclone wind in the storm of May and June 1881 might be used, *viz.*, a wind of 15·3 miles per hour from S 21° W. This would probably be suitable for the western half of the Arabian Sea. For the eastern half a more westerly direction, say WSW, would probably be preferable; but

the use, for this purpose, of almost any roughly estimated monsoon wind would give better results than those obtained by neglecting altogether to take it into account. In drawing figures 4 and 5 the monsoon wind has been assumed to be from S 21° W with a velocity of 15·3 miles per hour.

The true direction and force of the actual wind is of course supposed to have been found by observation, but it should not be forgotten that the true direction and force cannot be found by direct observation on a rapidly moving vessel. Either, then, the vessel should be stopped to make a correct observation, or allowance should be made for the wind which is produced by the motion of the vessel. This effect of the motion of the vessel can easily be eliminated from the observed wind by constructing another figure similar to the one already described. Thus:—

1st. Draw an arrow, No. 1, to represent the observed wind while the vessel is in motion as in figure 6, Plate XXXVII.

2nd. Draw another arrow, No. 2, to represent the wind produced by the motion of the ship. This, of course, will be a wind blowing in the opposite direction to that in which the vessel is moving, and of the same velocity as that of the ship. No. 2 must be drawn with its head touching the head of No. 1.

3rd. Draw a third arrow, No. 3, from the tail of No. 1 to the tail of No. 2 with its head on the tail of No. 2. No. 3 will represent the actual wind, uninfluenced by the motion of the ship.

The importance of these considerations, more especially to homeward bound steamers from Bombay will be seen by the following example. Suppose the course of a vessel to be S 76° W from Bombay towards Aden, and that she is steaming at the rate of 12 miles per hour, also that the wind observed on the ship while in motion is from SSE and of force 7, or 40 miles per hour. Allowing for the effect of the motion of the vesssl the actual wind will be found to be from a direction about one point more easterly than the observed wind as shown by *figure 6*. Suppose, also, that the monsoon wind is from WSW, blowing at the rate of 15 miles per hour. Allowing for this also, the cyclone wind is found to be from a direction 33°, or about 3 points, to the eastward of the observed wind, as in figure 6. Hence it appears that, if the bearing of the centre of the cyclone, in accordance with the usual rule, be reckoned at 6 points to the left of the observed wind, standing with the back to it, the centre will bear almost due west, whereas the true bearing, *viz.*, that reckoned from the direction of the cyclone wind would, by the same rule, be 3 points more to the south, that is SW by W. It appears, then, that in a case of this kind the application of the usual rule to the observed wind would give a very misleading result. It is therefore necessary that the effects of the motion of the ship, and of the monsoon wind, on the bearing of the centre, should both be taken into account and due allowance made for them.

Having found the bearing of the centre, it is clear that if the course of the vessel can be changed so as to make an angle of not less than 90°, or eight points, with the bearing of the centre, either to the right or to the left of the line drawn towards the centre, the vessel will not itself move any nearer to the centre, and the barometer will at once cease to fall, and soon begin to rise, unless the whole cyclone is moving bodily towards the ship or very rapidly increasing in size, in either of which cases the barometer will continue to fall, and a greater deviation of the course of the vessel from the direction of

the centre will be necessary. If, however, after changing the course of the vessel, the barometer should begin to rise, it will be a proof that the distance between the centre and the ship is increasing; while if the barometer should remain stationary it will show that the cyclone is either travelling in the same direction as the ship, or is rapidly increasing in size.

The best plan seems therefore to be to deviate not less than eight points to the right or the left of the line drawn towards the centre, to watch the barometer, and be guided by its movements, always acting in such a way as to prevent a further fall or cause a rise of the barometer by deviating from the direction of the centre as much as may be needful for this purpose. The choice of directions in which to deviate, whether to the right or left, will depend on many considerations, on sea room, on the course the vessel is steering, on the strength of the wind, on the direction in which the storm centre is moving, on the kind of ship, whether a steamer or a sailing vessel, &c. It must therefore of necessity be left to the judgment of the navigator. However, a steamer going eastward, and meeting with a wind of force 7 or 8 from any direction between NE and W round by N, with a rapidly falling barometer, would probably find it best to deviate to the right; but if the wind force does not exceed 8, and the wind is from any direction between NE and SE, it would probably be best to deviate somewhat out of her course towards the NE. A steamer going westward would probably first meet with a favourable south-easterly breeze, and in this case there is great temptation to run on and cross in front of the storm, and so out of its influence, but unless by deviating to the right the barometer can be kept from falling dangerously low, and unless the vessel can outstrip the storm, which would be shown by the gradual backing of the wind to E and NE, and after passing the centre, by a rising barometer, it would be better to heave to and wait till the cyclone passes away to the north-westward. Two steamers attempting to pass from east to west across the north semi-circle of the cyclone of May-June 1881, received so much damage as to be compelled to put back to Bombay, although in one case the barometer was reported to have fallen only to 29·4".

With respect to the motion of the storm centre, the previous investigation has shown that the rule of six points to the left of the direction towards which the normal monsoon wind blows, would have been a very good rule for indicating the direction towards which the centre of the cyclone of May-June 1881 moved. This rule is in very fair agreement with what is at present known of the paths of cyclones in the Arabian Sea, and it will probably prove to be a very good guide for the future. It is very desirable that it should be verified by detailed discussion of the path of many more storms, before placing very great confidence in it. Nevertheless, in the present state of our knowledge, it is probably the best general rule that can be given for the Arabian Sea.

In the foregoing discussion constant reference has been made to the normal barometric pressure, and to the depression of the barometer below the normal. This depression is the best guide the navigator can have to aid him in estimating the probability of rough weather. He should therefore be able to calculate for himself its amount. It is not neccessarily the same thing as a simple fall of the barometer, but it is the fall below the average pressure of the time and place. For instance, on a voyage from Colombo to Karachi in June, the barometer would ordinarily fall about three-tenths of an inch, because in this month the average pressure at Karachi is so much below the average

pressure at Colombo. Such a fall, if gradual, would not indicate anything unusual in the state of the weather. Indeed in this case the depression of the barometer below the normal would be nothing, the whole fall being accounted for by the difference of the normal or average June pressures of the two places. If, however, a fall of three-tenths was observed on a voyage between Bombay and Aden in the same month, nearly the whole fall would be a real depression below the normal, because the normal pressures along this route vary very little. Such a fall on this route would therefore indicate an excessive disturbance of the ordinary weather conditions. The data required for finding the depression below the normal are—

1st.—The normal pressure of the time and place.

2nd.—The actual pressure at the time of observation.

The first is obtained directly from charts of the average pressure in each month. The second can be obtained by observation of the barometer, and by the application to the observed reading of the needful corrections, as in the following example :—

Data.—Approximate position of ship. Lat. 17° N. Long. 66° E.

Reading of barometer at 8 A.M. June 15.	29·556 inches.	
Attached thermometer	83·5 degrees.	
Index error of barometer	—·062 inch.	
Height of barometer cistern above the sea	22 feet.	
Calculation.—Uncorrected reading of barometer		29·556
Correction for Index error of barometer		+ ·062
Reading corrected for index error only		29·618
Correction for temperature (to 32° Fahr.)		— ·145
Reading corrected for index error and temperature		29·473
Correction for height above the sea		+ ·022
Reading corrected for index error, temperature and to sea level		29·495
Normal Pressure read from Chart		29·82
Correction to 8 A.M. for diurnal variation		+ ·025
Normal Pressure at 8 A.M.		29·845
Actual observed and corrected pressure at 8 A.M.		29·495
Depresssion below the normal		— ·350

The corrections for temperature, to sea-level, and for diurnal variation, may be taken from the small "Barometer Manual for the use of seamen," published by the London Meteorological Office.

By making frequent observations and calculations of this kind, and plotting out the results on a large scale by the method illustrated in Plate XXXVIII, the navigator will have before him a graphic representation of the barometric features of the storm, which, combined with his observations of the wind, will enable him to decide with confidence on the best course to steer, so as to keep as far as possible from the centre of the cyclone.

One other valuable indication of rough cyclonic weather is deducible from this investigation. It is well known that cyclones raise a very high confused sea, and that the confusion becomes greater as the centre is approached. It appears, however, from the pre-

ceding discussion, that in the outer parts of the cyclone, the confusion is not so great as to prevent observation of the direction from which most of the swell is rolling, and this direction is usually found to be several points to the right of that from which the wind is blowing. It is easy to understand this fact if the wind in each octant of the cyclone raises, in its own direction, a sea which travels onward to a considerable distance from the place where it originates. For if so, the sea in one octant of the cyclone would be raised not so much by the wind in that octant, as by the wind in the adjacent octant to windward; and the sea raised by the wind in the former octant would travel into, and be felt most in, the octant to leeward. In this way the sea in any octant would come mostly from a direction to the right of that from which the wind blows, because, on account of the rotation of the wind in the cyclone, the wind in the adjacent octant to windward is from a direction to the right of the direction from which the wind blows in the first octant. In the south octant, for instance, the wind is from about south-west, while in the south-west octant it is from about west, that is, from a direction about four points to the right of south-west. If therefore the sea in the south octant is mostly raised by the wind in the south-west octant, it will come from west instead of from south-west. If this is the true explanation of the numerous observations made in the outer parts of the cyclone of May—June 1881, showing that the sea came from a direction several points to the right of the wind, it follows that, whenever a heavy sea is observed to be rolling from a direction several points to the right of the wind, the inference will be that the vessel is probably in the immediate neighbourhood of a cyclone. In the southern hemisphere, where cyclones rotate in the opposite direction, the sea should come from a direction several points to the *left* of the wind. It would be interesting to know whether this is really the case.

It should also be pointed out that whenever the south-westerly monsoon wind rises much above its normal strength, there is reason to believe that a cyclonic disturbance exists to the northward of the vessel. If such be really the case, a deviation towards the south would bring the ship into less boisterous weather.

Observations of the Direction and Velocity of the Wind at the Colaba Observatory, Bombay, on the 28th to the 31st May 1881, and their relation to the Cyclone.

The following tables contain the hourly tabulations of the directionand velocity of the wind on the 28th to the 31st May 1881, taken from the anemograms produced by the Anemograph at the Colaba Observatory, Bombay, which were kindly lent by the Director of the Observatory. The headings of the several columns of these tables explain themselves—

TABLE XXXVIII.—COLABA OBSERVATORY, BOMBAY.

Wind Observations on the 28th May 1881.

Hour.	Direction.	Velocity in miles per hour.	North component N + S−	East component E + W−	Normal North component.	Normal East component.	Abnormal North component.	Abnormal East component.	Abnormal Direction.	Abnormal Velocity.
0 to 1	SSW	7	− 6·5	− 2·7	−3·3	− 4·3	− 3·2	+ 1·6	S 27° E	4
1 to 2	SE	11	− 7·8	+ 7·8	−3·4	− 4·2	− 4·4	+12·0	S 70° E	13
2 to 3	SSE	15	−13·9	+ 5·7	−3·4	− 3·5	−10·5	+ 9·2	S 41° E	14
3 to 4	SSE	17	−15·7	+ 6·5	−3·2	− 3·0	−12·5	+ 9·5	S 37° E	16

Hour.	Direction.	Velocity in miles per hour.	North component N + S−	East component E + W−	Normal North component.	Normal East component.	Abnormal North component.	Abnormal East component.	Abnormal Direction.	Abnormal Velocity.
4 to 5	SE	12	− 8·5	+ 8·5	−3·2	− 2·3	− 5·3	+10·8	S 64° E	12
5 to 6	SE	9	− 6·4	+ 6·4	−3·4	− 1·7	− 3·0	+ 8·1	S 70° E	9
6 to 7	SE	13	− 9·2	+ 9·2	−3·6	− 1·3	− 5·6	+10·5	S 62° E	12
7 to 8	SE	15	−10·6	+10·6	−3·7	− 1·2	− 6·9	+11·8	S 60° E	14
8 to 9	S	19	−19·0	0·0	−4·0	− 2·3	−15·0	+ 2·3	S 9° E	15
9 to 10	S	18	−18·0	0·0	−4·0	− 4·5	−14·0	+ 4·5	S 18° E	15
10 to 11	SSW	19	−17·6	− 7·3	−3·5	− 7·2	−14·1	− 0·1	S	14
11 to 12	SSW	15	−13·9	− 5·7	−3·0	− 9·0	−10·9	+ 3·3	S 17° E	11
12 to 13	SW	12	− 8·5	− 8·5	−2·6	−11·2	− 5·9	+ 2·7	S 25° E	6
13 to 14	SW	15	−10·6	−10·6	−1·9	−12·3	− 8·7	+ 1·7	S 11° E	9
14 to 15	SW	12	− 8·5	− 8·5	−1·1	−13·5	− 7·4	+ 5·0	S 34° E	9
15 to 16	SSW	19	−17·6	− 7·3	−0·8	−13·5	−16·8	+ 6·2	S 20° E	18
16 to 17	SSW	22	−20·3	− 8·4	−0·6	−13·2	−19·7	+ 4·8	S 13° E	20
17 to 18	SSW	21	−19·4	− 8·0	−0·9	−11·6	−18·5	+ 3·6	S 11° E	19
18 to 19	S	26	−26·0	0·0	−1·2	− 9·8	−24·8	+ 9·8	S 22° E	27
19 to 20	S	25	−25·0	0·0	−1·4	− 7·8	−23·6	+ 7·8	S 18° E	25
20 to 21	S	27	−27·0	0·0	−2·3	− 6·5	−24·7	+ 6·5	S 15° E	26
21 to 22	S	31	−31·0	0·0	−2·4	− 5·9	−28·6	+ 5·9	S 12° E	29
22 to 23	SSE	32	−29·6	+12·2	−2·9	− 5·6	−26·7	+17·8	S 34° E	32
23 to 24	SSE	32	−29·6	+12·2	−3·2	− 4·7	−26·4	+16·9	S 33° E	31
Daily Resultant.	S 17° E	17	−16·7	+ 0·5	−2·6	− 6·7	−14·1	+ 7·2	S 27° E	16

TABLE XXXIX.—COLABA OBSERVATORY, BOMBAY.

Wind Observations on the 29th May 1881.

Hour.	Direction.	Velocity in miles per hour.	North component N + S−	East component E + W −	Normal North component.	Normal-East component.	Abnormal North component.	Abnormal East component.	Abnormal Direction.	Abnormal Velocity.
0 to 1	SSE	32	−29·6	+12·2	−3·6	− 4·3	−26·0	+16·5	S 32° E	31
1 to 2	SSE	31	−28·6	+11·9	−3·7	− 4·2	−24·9	+16·1	S 33° E	30
2 to 3	SSE	27	−24·9	+10·3	−3·7	− 3·5	−21·2	+13·8	S 33° E	25
3 to 4	SSE	28	−25·9	+10·7	−3·5	− 3·0	−22·4	+13·7	S 31° E	26
4 to 5	SSE	26	−24·0	+ 9·9	−3·5	− 2·3	−20·5	+12·2	S 31° E	24
5 to 6	SE	21	−14·8	+14·8	−3·7	− 1·7	−11·1	+16·5	S 56° E	19
6 to 7	SSE	29	−26·8	+11·1	−3·9	− 1·3	−22·9	+12·4	S 29° E	26
7 to 8	SSE	33	−30·5	+12·6	−4·0	− 1·2	−26·5	+13·8	S 28° E	30
8 to 9	SSE	27	−24·9	+10·3	−4·3	− 2·3	−20·6	+12·6	S 31° E	24
9 to 10	S	32	−32·0	0·0	−4·3	− 4·5	−27·7	+ 4·5	S 9° E	28
10 to 11	S	33	−33·0	0·0	−3·8	− 7·2	−29·2	+ 7·2	S 14° E	30
11 to 12	S	32	−32·0	0·0	−3·3	− 9·0	−28·7	+ 9·0	S 17° E	30

Hour.	Direction.	Velocity in miles per hour.	North component N + S −	East component E + W −	Normal North component.	Normal East component.	Abnormal North component.	Abnormal East component.	Abnormal Direction.	Abnormal Velocity.
12 to 13	SSW	32	−29·6	−12·2	−2·9	−11·2	−26·7	− 1·0	S 3° W	2 7
13 to 14	SSW	33	−30·5	−12·6	−2·2	−12·3	−28·3	− 0·3	S 1° W	28
14 to 15	SSW	28	−25·9	−10·7	−1·4	−13·5	−24·5	+ 2·8	S 7° E	25
15 to 16	SSW	26	−24·0	− 9·9	−1·1	−13·5	−22·9	+ 3·6	S 9° E	23
16 to 17	SSW	28	−25·9	−10·7	−0·9	−13·2	−25·0	+ 2·5	S 6° E	25
17 to 18	SW	19	−13·4	−13·4	−1·2	−11·6	−12·2	− 1·8	S 8° W	12
18 to 19	SSW	23	−21·2	− 8 8	−1·5	− 9·8	−19·7	+ 1·0	S 3° E	20
19 to 20	S	24	−24·0	0·0	−1·7	− 7·8	−22·3	+ 7·8	S 19° E	24
20 to 21	S	21	−21·0	0·0	−2·6	− 6·5	−18·4	+ 6·5	S 19° E	19
21 to 22	S	19	−19·0	0·0	−2·7	− 5·9	−16·3	+ 5·9	S 20° E	17
22 to 23	SSE	18	−16·6	+ 6·9	−3·2	− 5·6	−13·4	+12·5	S 43° E	18
23 to 24	SSE	20	−18·5	+ 7·7	−3·5	− 4·7	−15·0	+12·4	S 40° E	19
Daily Resultant.	S 4° E	25	−24·9	+ 1·7	−2·9	− 6·7	−22·0	+ 8·4	S 21° E	23·5

TABLE XL.—COLABA OBSERVATORY, BOMBAY.

Wind Observations on the 30th May 1881.

Hour.	Direction.	Velocity in miles per hour.	North component. N + S −	East component. E + W −	Normal North component.	Normal East component.	Abnormal North component.	Abnormal East component.	Abnormal Direction.	Abnormal Velocity.
0 to 1	SSE	21	−19·4	+ 8·0	−3·8	− 4·3	−15·6	+12·3	S 38° E	20
1 to 2	SSE	14	−12·9	+ 5·4	−3·9	− 4·2	− 9·0	+ 9·6	S 47° E	13
2 to 3	SSE	23	−21·2	+ 8·8	−3·9	− 3·5	−17·3	+12·3	S 35° E	21
3 to 4	SE	20	−14·1	+14·1	−3·7	− 3·0	−10·4	+17·1	S 59° E	20
4 to 5	SE	17	−12·0	+12·0	−3·7	− 2·3	− 8·3	+14·3	S 60° E	16
5 to 6	SE	20	−14·1	+14·1	−3·9	− 1·7	−10·2	+15·8	S 57° E	19
6 to 7	SE	20	−14·1	+14·1	−4·1	− 1·3	−10·0	+15·4	S 57° E	18
7 to 8	SSE	32	−29·6	+12·2	−4·2	− 1·2	−25·4	+13·4	S 28° E	29
8 to 9	SSE	28	−25·9	+10·7	−4·5	− 2·3	−21·4	+13·0	S 32° E	25
9 to 10	SSE	32	−29·6	+12·2	−4·5	− 4·5	−25·1	+16·7	S 34° E	30
10 to 11	S	35	−35·0	0·0	−4·0	− 7·2	−31·0	+ 7·2	S 13° E	32
11 to 12	S	35	−35·0	0·0	−3·5	− 9·0	−31·5	+ 9·0	S 16° E	33
12 to 13	SSW	36	−33·3	−13·8	−3·1	−11·2	−30·2	− 2·6	S 5° W	30
13 to 14	S	34	−34·0	0·0	−2·4	−12·3	−31·6	+12·3	S 21° E	34
14 to 15	S	32	−32·0	0·0	−1·6	−13·5	−30·4	+13·5	S 24° E	33
15 to 16	SSW	34	−31·4	−13·0	−1·3	−13·5	−30·1	+ 0·5	S 1° E	30
16 to 17	S	28	−28·0	0·0	−1·1	−13·2	−26·9	+13·2	S 26° E	30
17 to 18	S	28	−28·0	0·0	−1·4	−11·6	−26·6	+11·6	S 24° E	29
18 to 19	SSW	27	−24·9	−10·3	−1·7	− 9·8	−23·2	− 0·5	S 1° W	23
19 to 20	S	26	−26·0	0·0	−1·9	− 7·8	−24·1	+ 7·8	S 18° E	25

Hour.	Direction.	Velocity in miles per hour.	North component N + S −	East component E + W −	Normal North component.	Normal East component.	Abnormal North component.	Abnormal East component.	Abnormal Direction.	Abnormal Velocity.
20 to 21	SSW	27	−24·9	−10·3	−2·8	− 6·5	−22·1	− 3·8	S 10° W	22
21 to 22	S	25	−25·0	0·0	−2·9	− 5·9	−22·1	+ 5·9	S 15° E	23
22 to 23	S	28	−28·0	0·0	−3·4	− 5·6	−24·6	+ 5·6	S 13° E	25
23 to 24	S	30	−30·0	0·0	−3·7	− 4·7	−26·3	+ 4·7	S 11° E	27
Daily Resultant.	S 6° E	25	−25·3	+ 2·7	−3·1	− 6·7	−22·2	+ 9·4	S 23° E	24·1

TABLE XLI.—COLABA OBSERVATORY, BOMBAY.

Wind Observations on the 31st May 1881.

Hour.	Direction.	Velocity in miles per hour.	North component N + S −	East component E + W −	Normal North component.	Normal East component.	Abnormal North component.	Abnormal East component.	Abnormal Direction.	Abnormal Velocity.
0 to 1	S	28	−28·0	0·0	−4·0	− 4·3	−23·7	+4·3	S 10° E	24
1 to 2	S	27	−27·0	0·0	−4·1	− 4·2	−22·9	+4·2	S 10° E	23
2 to 3	SSW	26	−24·0	− 9·9	−4·1	− 3·5	−19·9	−6·4	S 18° W	21
3 to 4	SSW	22	−20·3	− 8·4	−3·9	− 3·0	−16·4	−5·4	S 18° W	17
4 to 5	SSW	20	−18·5	− 7·7	−3·9	− 2·3	−14·6	−5·4	S 26° W	16
5 to 6	SSW	23	−21·2	− 8·8	−4·1	− 1·7	−17·1	−7·1	S 22° W	18
6 to 7	SSW	23	−21·2	− 8·8	−4·3	− 1·3	−16·9	−7·5	S 24° W	18
7 to 8	SSW	20	−18·5	− 7·7	−4·4	− 1·2	−14·1	−6·5	S 25° W	15
8 to 9	SSW	21	−19·4	− 8·0	−4·7	− 2·3	−14·7	−5·7	S 21° W	16
9 to 10	SSW	23	−21·2	− 8·8	−4·7	− 4·5	−16·5	−4·3	S 15° W	17
10 to 11	SSW	17	−15·7	− 6·5	−4·2	− 7·2	−11·5	+0·7	S 4° E	11
11 to 12	SW	15	−10·6	−10·6	−3·7	− 9·0	− 6·9	−1·6	S 13° W	7
12 to 13	SW	13	− 9·2	− 9·2	−3·3	−11·2	− 5·9	+2·0	S 19° E	6
13 to 14	SW	13	− 9·2	− 9·2	−2·6	−12·3	− 6·6	+3·1	S 25° E	7
14 to 15	SW	16	−11·3	−11·3	−1·8	−13·5	− 9·5	+2·2	S 13° E	10
15 to 16	SW	12	− 8·5	− 8·5	−1·5	−13·5	− 7·0	+5·0	S 36° E	9
16 to 17	SW	13	− 9·2	− 9·2	−1·3	−13·2	− 7·9	+4·0	S 27° E	9
17 to 18	SW	13	− 9·2	− 9·2	−1·6	−11·6	− 7·6	+2·4	S 18° E	8
18 to 19	SW	15	−10·6	−10·6	−1·9	− 9·8	− 8·7	−0·8	S 5° W	9
19 to 20	SW	11	− 7·8	− 7·8	−2·1	− 7·8	− 5·7	0 0	S	6
20 to 21	SW	16	−11·3	−11·3	−3·0	− 6·5	− 8·3	−4·8	S 29° W	9
21 to 22	SW	11	− 7·8	− 7·8	−3·1	− 5·9	− 4·7	−1·9	S 22° W	5
22 to 23	SW	14	− 9·9	− 9·9	−3·6	− 5·6	− 6·3	−4·3	S 34° W	7
23 to 24	SW	11	− 7·8	− 7·8	−3·9	− 4·7	− 3·9	−3·1	S 38° W	5
Daily Resultant.	S 29° W	17	−14·9	− 8·2	−3·3	− 6·7	−11·6	−1·5	S 7° W	12

From these tables it appears that the abnormal wind first became unusually strong between 3 and 4 o'clock on the afternoon of the 28th May, when it blew from SSE. By midnight the abnormal velocity had increased to about 30 miles per hour, at which rate it

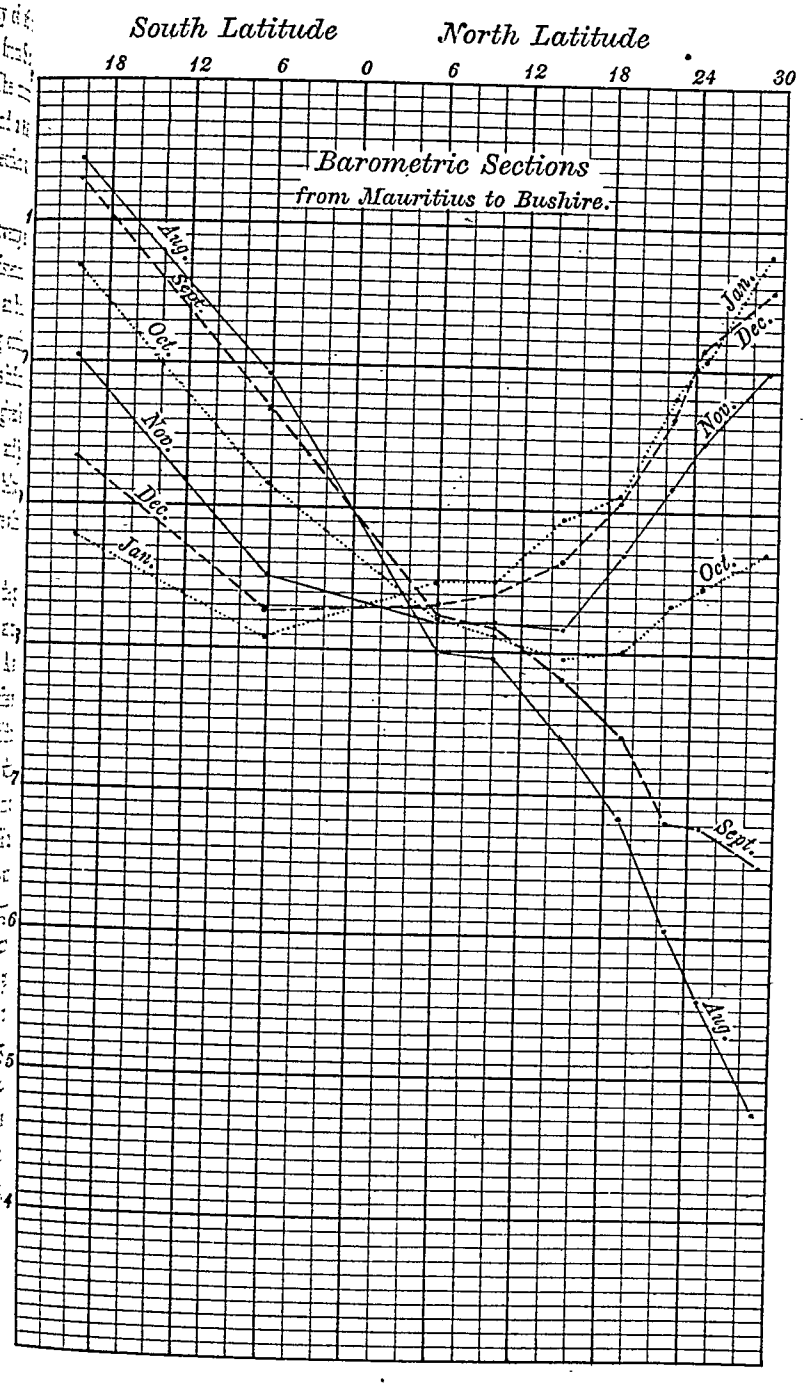
continued till noon of the 29th. After this there was a lull till about 7 A.M., of the 30th, when it again strengthened to about the same rate as before, *viz.* 30 miles per hour, and remained strong from about the same direction, SSE, until after midnight of the 31st, when it veered to SSW, and gradually died out about noon. On the 28th the resultant abnormal wind for the twenty-four hours was from S 27° E, with a velocity of 16 miles per hour; on the 29th it was from S 21° E, velocity 24 miles; on the 30th from S 23° E, velocity 24 miles; and on the 31st it was from S 7° W, velocity 12 miles. The maximum abnormal wind for any single hour during these days occurred between 1 and 2 P.M. on the 30th, when the abnormal velocity was 34 miles for the hour, and the direction of the abnormal wind was S 21° E.

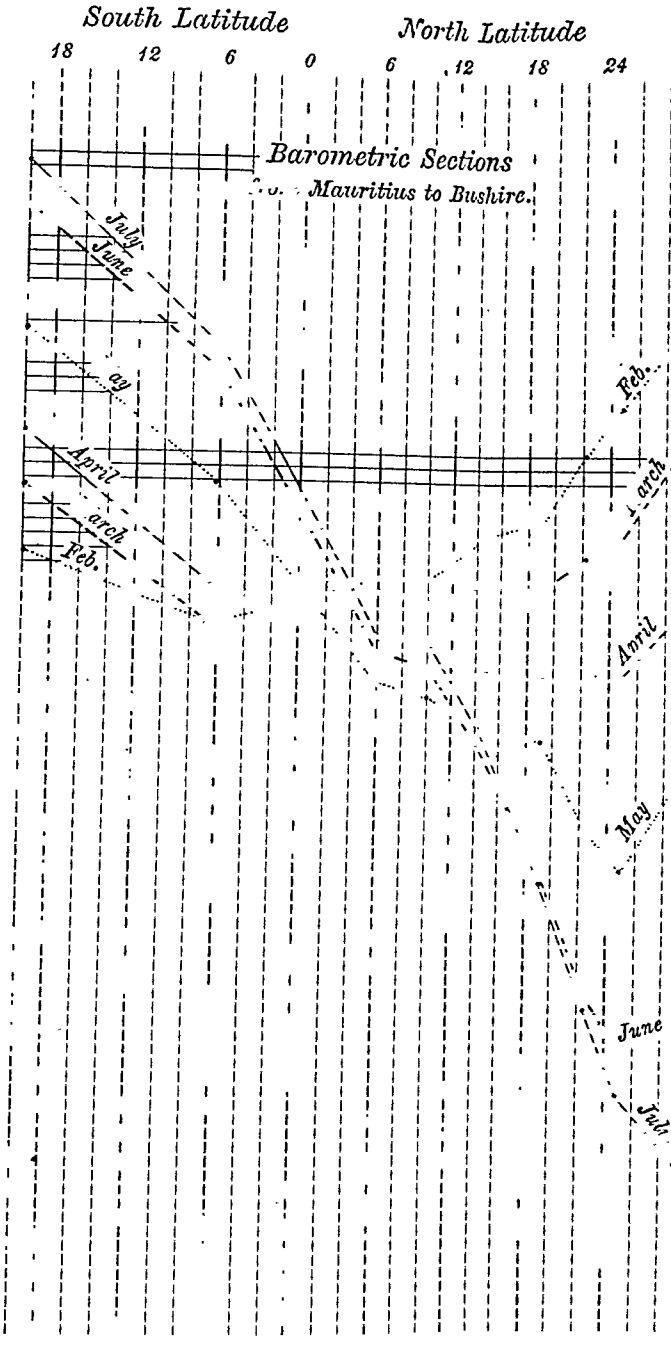
The velocity of the abnormal wind at Bombay very rarely exceeds twenty miles an hour except during a local squall or when a cyclonic disturbance is in existence. In the former case the wind is always of short duration, lasting not longer than an hour or two, but in the latter, it usually continues for two or three days. Any long continued abnormal wind of more than twenty miles an hour may therefore be regarded as indicative of the existence of a cyclonic disturbance, although the barometer may have given little or no indication of it. This was the case at Bombay in the cyclone of May and June 1881, when the barometer did not fall even as much as a tenth of an inch below the normal, but when the abnormal wind blew for two or three days with an average velocity of more than twenty miles an hour.

The cyclone reached its maximum development on the 31st. At noon on the 30th the centre was almost due west of Bombay at a distance of about 620 miles, and at noon on the 31st it was a little to the north of west at a distance of about 730 miles. At the latter hour the abnormal wind at Bombay had dwindled down to only about 7 miles per hour from the southward. Now, if the whole storm field be defined as that within which the influence of the cyclone was distinctly recognisable by the strength of the abnormal winds, it follows that on the 30th Bombay was well within the field, and on the 31st, at noon, on the outer margin of it. Hence it appears that the maximum diameter of the storm field can hardly have been much less than 1,400 miles. It must not be supposed that the winds were very violent and dangerous over the whole of this area. Indeed the diameter of the dangerous central part over which winds of force 8 or more were blowing was probably not more than one-third of the whole diameter of the storm field, that is to say, not more than 500 miles at most. But surrounding the dangerous central part, and at the time when the cyclone had reached its full development, there would be a ring, somewhat less than 500 miles wide, in which the abnormal winds, or, in other words, the cyclone winds, would gradually increase in strength from nothing on the extreme outer margin to force 8 on the inner margin, and beyond which and nearer the centre, the winds would become dangerous. By regularly observing the direction and the velocity or force of the wind and eliminating the normal monsoon wind and the wind caused by the motion of the ship in the manner already described, it will be possible to find out when the ship is in the neighbourhood of a cyclone; and this information will always be obtainable before she has entered the dangerous central part of it.

A small anemometer for measuring the velocity of the wind would be found very useful, because it is always difficult to determine accurately the force of the wind by mere estimation.

Government of India Central Printing Office.—No. 3 Meteor.—16-9-88.—400.





Lithographed at the Survey of India Offices, Calcutta, September 1893.

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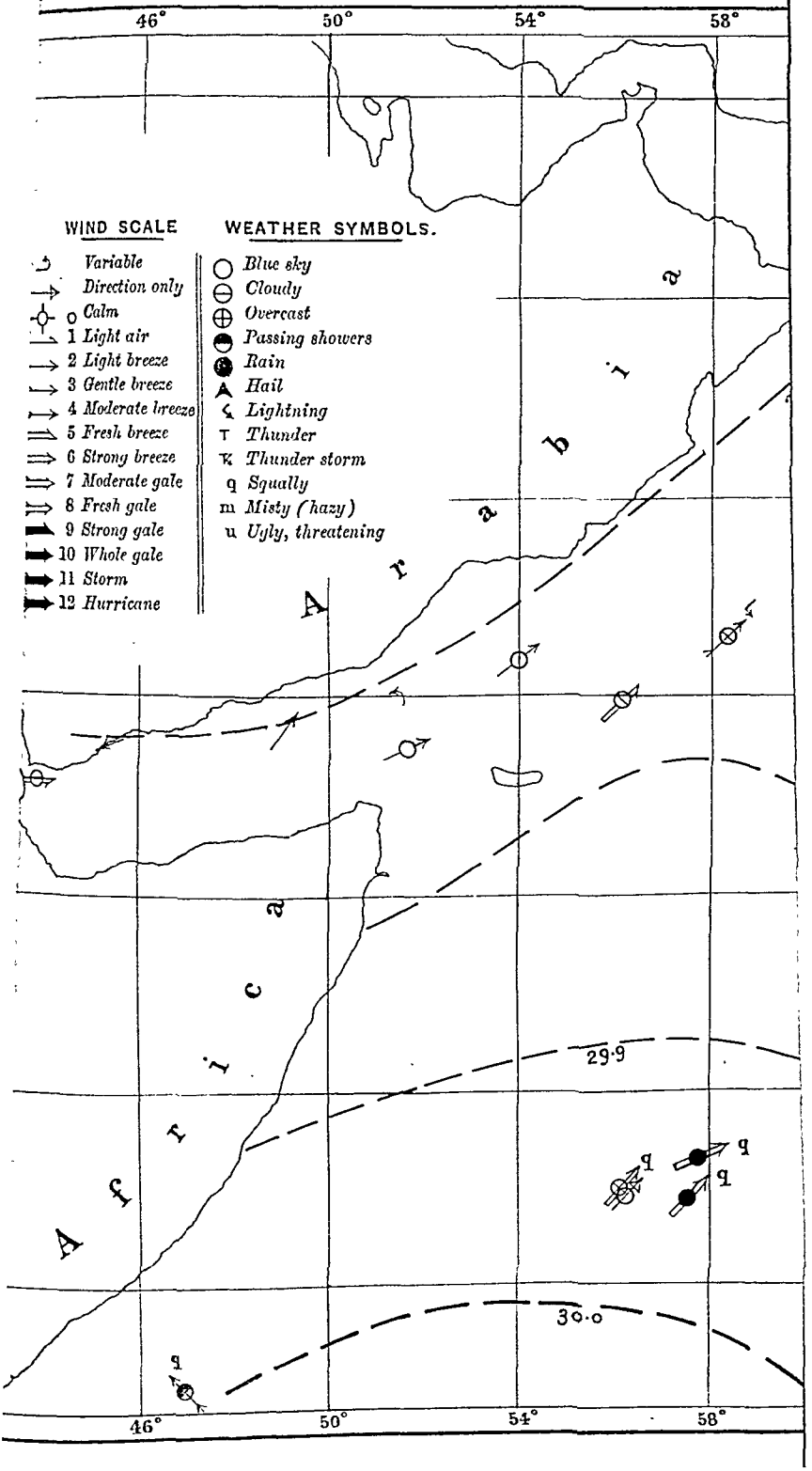

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